March 14, 1935

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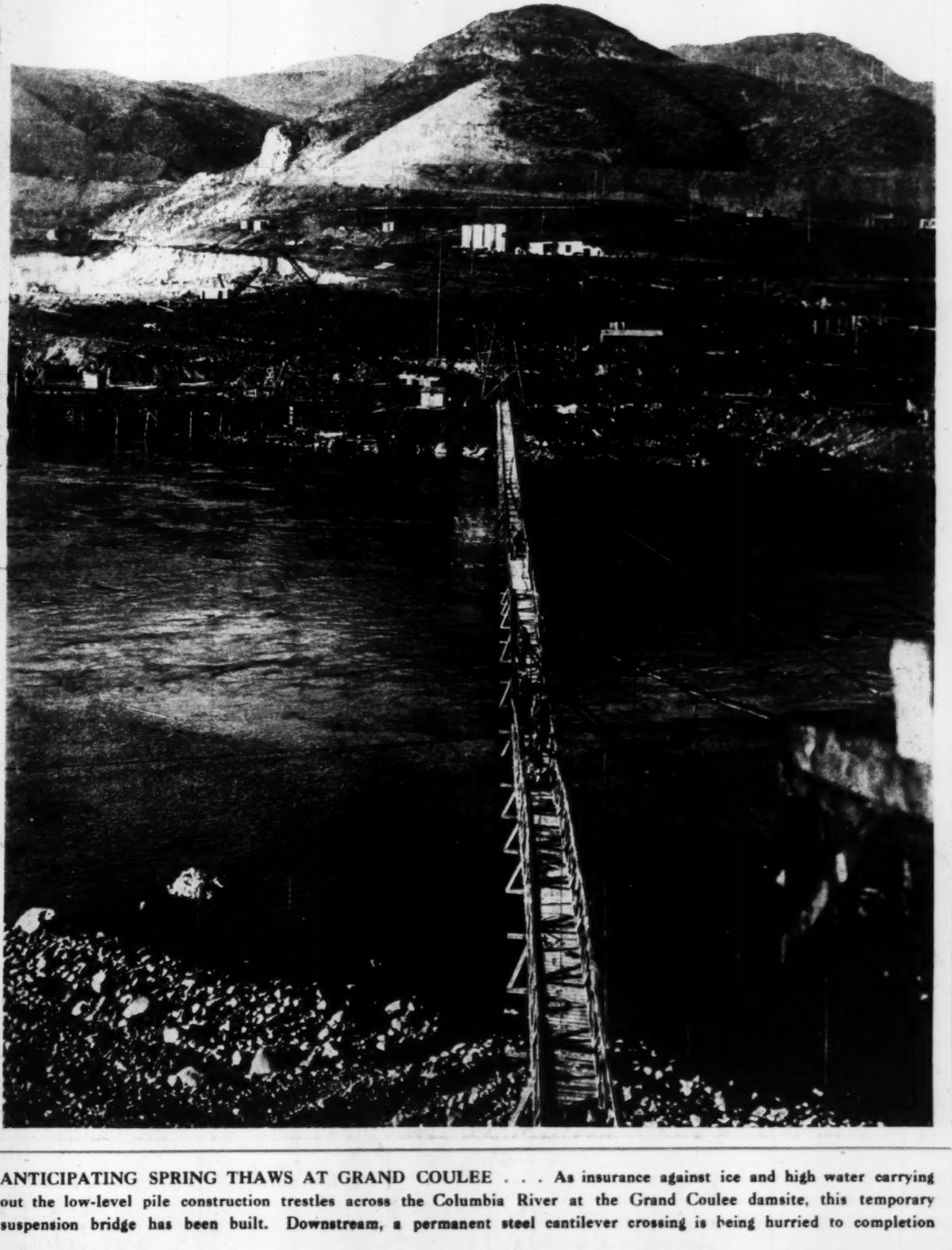

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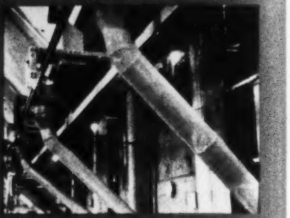

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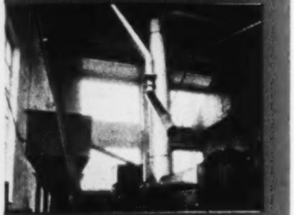

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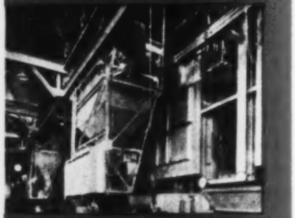

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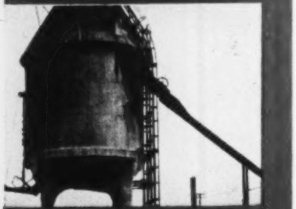

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A MOMENT WITH THE PUBLISHERS

Time for Direct Contact

DURING the last few years business and politics have become bedfellows. Not so long ago most business men lived wholly for business. To them politics was a world apart, run by and for politicians. Although the business man might decry the evils of politics he felt little personal responsibility for them. Some voted on Election Day; some could not spare even the time for that; a very few actually voted at the primaries for a party slate. By and large, business and politics lived at opposite ends of the town.

Today all this is changed. Now all business seems to be politics and all politics business. Washington has become the business capital as well as the political capital of the nation. The policies of the President and the enactments of Congress deal almost exclusively with business and with those public functions that are auxiliary to business.

For some of this change business itself is responsible. Confronted by a crisis, business turned quickly to government for help; the preservation of certain business institutions became a dominant concern of the state. Some responsibility rests with those students of government and economics who believe that government should extend its sway and strengthen its control within the field of business, and some with those statesmen and politicians who sensed in such a trend a political opportunity. Whatever the cause or the justification, the fact remains that politics and politicians have become a major concern of the business man.

Since March, 1933, the executive arm of politics has dominated the legislative, i.e., the President has dominated Congress. So business has been dealing with the President in political matters that concern their business. To him they have offered their counsel and their arguments; his influence they have invoked against destructive measures, and to him they have ascribed full credit or blame for the success or failure of government in handling the political aspects of business problems.

But now the political prophets forecast change. The President, they tell us, is losing his control over Congress; the legislators are feeling their oats and taking the bit in their teeth; they do not show the same deference to presidential leadership that they did during the crisis.

To business this trend should indicate the danger of dealing exclusively with the President in its efforts to fight destructive legislation and conserve business interests. If the President's control over Congress is relaxed, that control should revert to those who sent the Senators and Congressmen to Washington. If the business men of the country no longer can maintain contact with Congress through the White House alone, they must maintain it directly—and more vigilantly and consistently than ever before. Else we shall have Congress adrift, scudding before every propagandist blast from the lobbies of organized minorities, each man dominated by his hopes or fears for the next election. If business would have its needs known and respected in Washington, if it would help the President to stand against a radical drift during the days just ahead of us, business now must assume more direct contact with its representatives.

This does not mean reliance on the super-lobbies of organized business. Quite to the contrary, it means the direct personal contact of each business man with his own Senator and his own Congressman. The power of the minority lobby resides almost wholly in the indifference and inaction of the great bulk of substantial and straight-thinking people. It is probable that every Senator and Congressman hears more insistently from such lobbies in Washington than he does from his own folks back home. And when he does hear from home it is more likely to be from irresponsible sewing-circles with half-baked ideas on national policies than from the business men of his community with responsible counsel on matters that affect their business welfare.

It is no time to rely exclusively on association contacts. The need is for direct individual contact by responsible business men with their own representatives. Today this kind of contact is producing results; the more of it that is forthcoming the more business men will help to keep Congress on the track and to strengthen the hand of the President in his efforts to avert radical excesses. And right now that should be the major concern of business.

Willard Chevalier

ENGINEERING NEWS-RECORD

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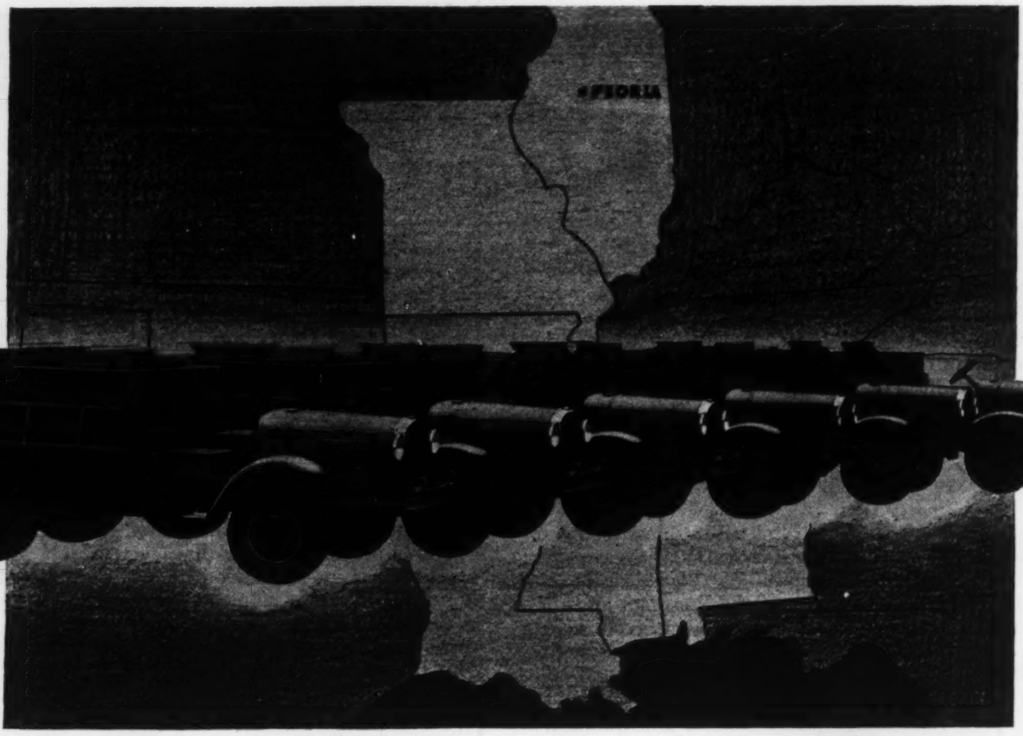

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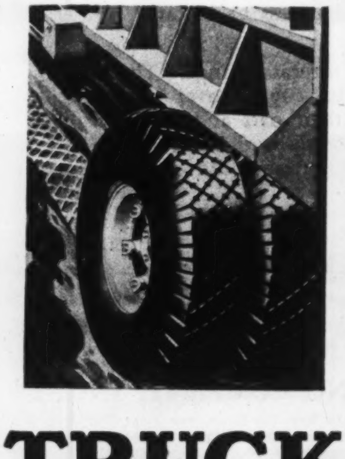

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In the News:

A STUDY OF SILTING in the Boulder Dam Reservoir has been undertaken by the federal government, to determine a factual basis for developing protective measures of erosion control and silt detention in the Colorado River drainage basin.

CONSIGNED to a watery grave, the caisson that was built for the south pier of the Golden Gate Bridge, but was not used when the construction plan was changed, was towed to sea and sunk.

"THE CONFERENCE with the President was most satisfactory," reported John Hogan, chairman of the Construction League of the United States, following an hour's discussion of the pending works program. The delegation included representatives of engineers, architects, contractors and building-trade unions.

PLANS for a permanent fair on the site of the Century of Progress in Chicago have been announced with a $20,000,000 construction program, which will hinge on the pending public-works measure.

In This Issue:

THE PROBLEM of scour below overfall dams has been attacked from many approaches and has been the subject of much technical writing. In the present article two engineers of the Bureau of Reclamation divide the conditions for establishing a hydraulic jump into four classifications and discuss these by means of reference to existing structures.

A RAPID METHOD for analyzing rigid viaduct bents has been evolved by Prof. L. C. Maugh, of the University of Michigan, from considerations and procedure used in analyzing Vierendeel trustees.

NOTEWORTHY DESIGN has been incorporated in several new dormitories on the campus of Stanford University, Palo Alto, Calif. The frame, of steel members only $\frac{1}{16}$ to $\frac{1}{8}$ in. thick, is completely welded and for the most part prefabricated into large units.

ANY ONE who has driven the Post Road between New York and Boston must have given some thought to the desirability of putting trucks on a highway of their own. A small beginning in this direction is now being made in Connecticut, where 9 miles of a 38-mile superhighway project paralleling the Boston Post Road is under construction, to accommodate motorists who wish to avoid the trucks.

A.R.E.A. Report: The report of the annual convention of the American Railway Engineering Association, held in Chicago this week, will be published in the issue of March 21.

This Week's Cover:

CONTINUED PROGRESS on the Grand Coulee Dam project requires uninterrupted connection between operations on both sides of the Columbia River, where 4-yd. electric shovels have excavated and belt conveyors have disposed of more than 1,000,000 cu.yd. of earth and rock up to March 1. This week's cover shows one excavating outfit at work and the new suspension bridge recently built to assure a bank-to-bank connection should high water take out the low-level construction trestles. Employment reached a peak of 2,700 men during February. The present project involves a concrete gravity dam 300 ft. high, for power only but with provision for raising to a 500-ft. height, to provide more power and a reduced head for pumping irrigation water into the Grand Coulee. An appropriation from the new $4,880,000,000 work-relief fund, to complete the high-dam project, has been rumored. The contractor's plant is said to be adequate for the high dam.

Beginning Next Week:

John F. Stevens' Recollections

IN "AN ENGINEER'S RECOLLECTIONS," John F. Stevens, pioneer railroad builder in the West and chief engineer of Panama Canal construction, looks backward over sixty years of a life more active than most members of the profession are privileged to experience. His first article to appear in *Engineering News-Record*, March 21, reviews the construction of the Canadian Pacific Railway across the prairies and mountains in the early 'eighties. Later "Recollections" will describe other events or periods in his career that stand out because of their keen engineering interest or historical significance. Few engineers now living have had the wide experience of John F. Stevens or have had a directing part in such momentous works of construction. His memories of his experiences promise to make a notable contribution to engineering literature.

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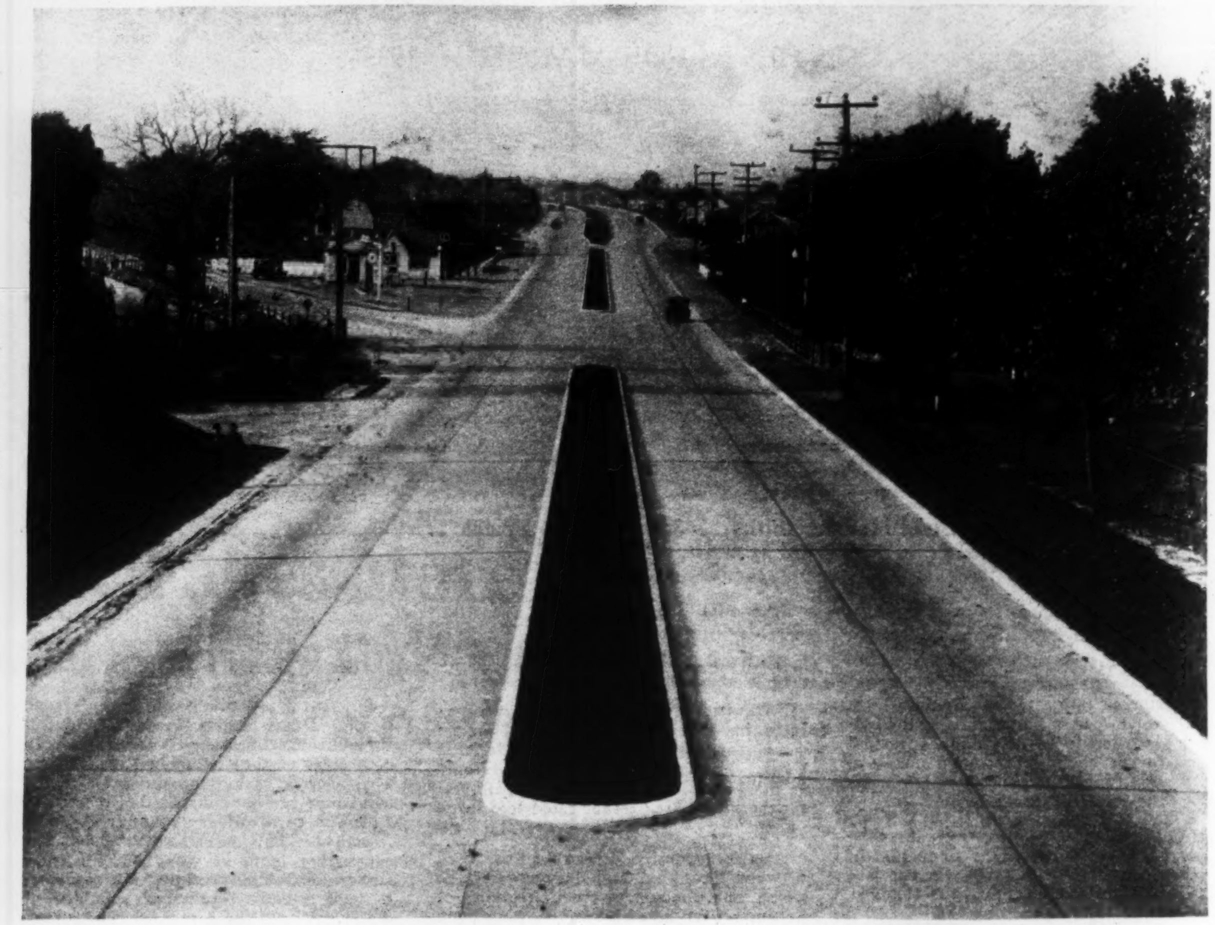
Atlas White concrete curbs make parkway and safety island stand out sharply and distinctly—and they make them stay that way.



Atlas White parkway curbing on U. S. Highway No. 13, leading into Smyrna, Delaware. Curbing installed by Gooden & Clark, Dover, Delaware, under supervision of the Delaware State Highway Department, W. W. Mack, Chief Engineer.

DRIVING into Smyrna, Delaware, you are impressed with the well-planned system of traffic control on the highway pictured here. Parkway islands separate incoming and outgoing traffic. On the outskirts the islands are seven feet wide. As the road widens in town, the islands widen to seventeen feet. And every island stands out clearly—easy to see for safety and nice to look at for appearance' sake—marked distinctly with spic and span *white* curbing made with Atlas White portland cement.

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ATLAS WHITE MARKERS AND CURBS

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March 14, 1935

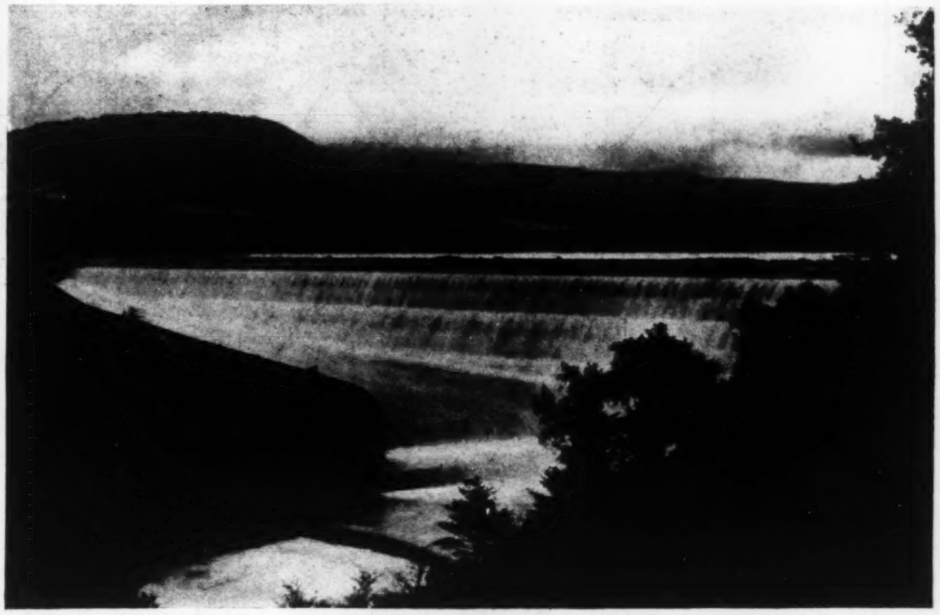


FIG. 1—GILBOA DAM of the New York City water-supply system is an outstanding example of dissipation of the energy of the overflow by spilling it down a series of steps on the face of the dam.

Protection Against Scour Below Overfall Dams

Four general conditions determine the form of spillway and type of apron required to protect the river bottom against scour — Need for model study emphasized and possibilities for savings therefrom indicated

By E. W. Lane and W. F. Bingham

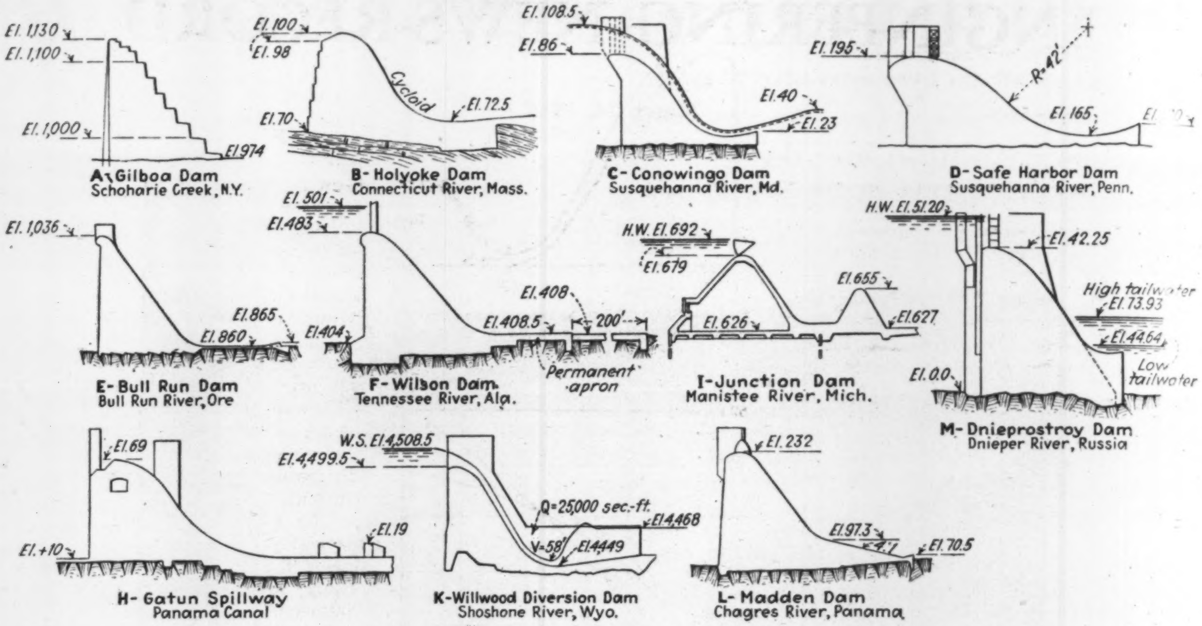
Research Engineer and Assistant Engineer, Respectively, U. S. Bureau of Reclamation, Denver, Colo.

A GREAT DEAL of study has been given to determining the best method of protecting the streambed below overfall dams against scour resulting from the high velocity and impact of the water flowing over them. A great variety of local conditions has been encountered, which has led to many different solutions, descriptions of which are widely dispersed through engineering literature. From a study of these articles and the results of hydraulic laboratory studies on dam spillways performed by the U. S. Bureau of Reclamation, the following analysis has been developed by the writers, which classifies the various conditions and points out the general types of scour protection applicable to each.

Scour below dams results from the erosive power of the water which comes into contact with the stream bottom while moving with the high velocity that it acquires in falling over the dam. Protection is afforded by reducing the velocity of the water, by insuring that the high-velocity flows do not come in contact with the bottom or are diverted to portions of the bottom which will not endanger the structure. Usually a combination of these is used.

On many dams in the past an attempt has been made to reduce the velocity of the water passing over them by having the water fall down a series of steps on the face of the dam, dissipating its energy by contact with the successive steps and reaching the bottom with insufficient energy remaining to erode the streambed seriously. An outstanding example of this type is the Gilboa Dam of New York City (Fig. 2-A). While the results on this dam have probably been successful, due to the carefully conducted model tests (*Trans.*, Am.Soc.C.E., Vol. 86, 1923, p. 280), without such studies the action on stepped weirs is apt to be different from that anticipated (*Civil Engineering*, October, 1932, p. 623); and as the principles of other forms of protection are becoming better understood, this form seems to be less frequently used. The present tendency is to dissipate the energy in some form of stilling pool or to divert the high-velocity stream so that it does not come into contact with the bottom where damage will result.

The most important factor in deter-



A-Gilboa Dam Schoharie Creek, N.Y.
B-Holyoke Dam Connecticut River, Mass.
C-Conowingo Dam Susquehanna River, Md.
D-Safe Harbor Dam Susquehanna River, Penn.
E-Bull Run Dam Bull Run River, Ore
F-Wilson Dam Tennessee River, Ala.
I-Junction Dam Manistee River, Mich.
M-Dnieprostroy Dam Dnieper River, Russia
H-Gatun Spillway Panama Canal
K-Willwood Diversion Dam Shoshone River, Wyo.
L-Madden Dam Chagres River, Panama

FIG. 2—TYPICAL SECTIONS of overfall dams, showing the various spillway forms used to protect against scour below the dam.

mining what form of protection should be used is the depth of water on the downstream side of the dam and its relation to the depth required to form the hydraulic jump.

In the most perfect form of hydraulic jump the energy of the high-velocity water is dissipated so thoroughly in internal impact that little energy remains to be used up in eddies and boils downstream. In the case of a dam with a well-formed jump at its toe, the velocity of the water is so quickly and uniformly reduced that little scour of bed and banks results. It is therefore desirable, whenever possible, to design the dam so that such a jump will occur, as the protection required for the bed and banks is thus reduced to a minimum.

The formula for the hydraulic jump in a horizontal channel of rectangular section is $D_2 = -\frac{D_1}{2} + \sqrt{\frac{2V_1^2 D_1}{g} + \frac{D_1^2}{4}}$ where D_1 and D_2 are the depths upstream and downstream from the jump respectively and V_1 and V_2 are the corresponding velocities. Consider an ogee dam, (Fig. 3) discharging 100 sec.-ft. per foot of length with a drop H equal to 50 ft. The velocity V_1 (neglecting friction) would then be $\sqrt{2g \times 50} =$ 56.8 ft. per second, and the depth D_1 would be $\frac{100}{\sqrt{2g \times 50}} = 1.76$ ft. Substituting in formula gives a value for D_2 of 19.7 ft., which is the height of tailwater required to form a perfect jump at the toe of the dam.

The ideal condition would be to have a tailwater at such a height above the riverbed for each discharge that it would form a perfect jump for the depth and velocity which would occur in the overfalling stream at the toe of the dam for that discharge. The height of the tailwater, however, is controlled by the conditions in the stream channel downstream from the dam, and this ideal condition is never exactly attained. Frequently the stage-discharge or tailwater rating curve at the downstream side of the dam is as shown in Fig. 4, but the curve that would be required to form the perfect jump on an apron at riverbed level is as shown by the jump-height curve A-B. This shows that for discharges of less than 20,000 sec.-ft. the tailwater height is greater than that required to form a perfect jump, but at greater discharges the tailwater height is too low.

The relations between the positions of these curves fall into the four following classes:

Class 1—Jump-height curve always above the tailwater rating curve.

Class 2—Jump-height curve always below the tailwater rating curve.

Class 3—Jump-height curve above the tailwater rating curve at low discharges and below at high discharges.

Class 4—Jump-height curve below the tailwater rating curve at low discharges and above at high discharges.

The best form of protection below a dam depends largely upon which of these conditions exist.

Class 1

The first class frequently occurs when a dam is placed at the head of a rapids or sudden drop in the streambed. Under these conditions the tailwater level is low and less than the height required to form the jump. Usually, too, the bed is of solid rock, which will withstand considerable scour. Under these conditions an upward curving apron is frequently put on the dam, which throws the stream of high-velocity water passing over the dam upward so that it strikes the streambed some distance away from the structure. Here the energy is dissipated by impact of the water on the river bottom and adjacent water; and although some scour takes place, it is too small and too far from the dam to endanger it. One of the earliest examples of this type of dam is the famous Holyoke Dam on the Connecticut River in Massachusetts (Fig. 2-B). Others are the Conowingo (*ENR*, Jan. 28, 1932, p. 127) and Safe Harbor dams on the Susquehanna River (Fig. 2-C and D).

At the Bull Run Dam (*Transactions*, Am.Soc.C.E., Vol. 93, 1929, p. 487) for the Portland, Ore., water supply (Fig. 2-E), a wide horizontal apron was used with upward sloping deflectors at the downstream edge, which directed the deflected stream so that when it fell back to the river level it was spread over a large area and consequently did not produce as severe scour as if the impact were localized.

The conditions on the Wilson Dam on the Tennessee River (Fig. 2-F) are such that it probably falls in Class 1. A wide level apron was constructed below this dam to protect the river bottom, but the depth of the tailwater was insufficient to cause the jump to form, and the high-velocity water passed entirely across the 200-ft. apron and eroded a large hole in the solid rock at its downstream edge (*ENR*, Feb. 8, 1927, p. 190). Experiments with a model of this dam have shown that piers would not cause the jump to form on the apron with the tailwater depth available.

When the tailwater depth is nearly sufficient to cause the jump, baffles or sills may be successfully used, but they often receive so much impact from drift or ice that they are expensive to build with a sufficiently strong anchorage. Baffles or piers do not dissipate as much energy as might be expected, and they are therefore not as effective as the hydraulic jump (*ENR*, Nov. 11, 1926, p. 800). Perhaps the best example of the use of baffle piers with a low tailwater level is in the Gatun spillway on the Panama Canal (Fig. 2-H). This spillway is designed to discharge as much as 140,000 sec.-ft. with a fall of nearly 75 ft. At the toe of the ogee section the water impinges directly against the flat faces of the baffle piers, and much of it is thrown high into the air, reaching almost as high an elevation as the water above the dam.* When this water falls to the river level it has nearly as great a velocity as it had at the toe of the dam. The principal effect of these baffle piers therefore is to distribute the impact over a large area rather than to dissipate the energy of the water.

If the tailwater level is not high enough to form a perfect jump, it may be raised by building a low secondary dam below the main dam with sufficient height to cause the jump to form at the foot of the main dam for all conditions of discharge. This method has been extensively used for dams on earth foundations. Such a form, developed by the Fargo Engineering Co., is shown in Fig. 2-I. This method has also been used for a rock foundation at the Martin Dam of the Alabama Power Co. The dimensions required for such a pool are shown by the experiments recently published in *Transactions*, Am.Soc.C.E., Vol. 99, 1934, p. 490.

Aother method which may be suitable in some cases is to excavate a pool just below the dam to provide a depth sufficient for the formation of the jump. In this case the tailwater level is not changed, but the depth required to form the jump is provided by the lowering of the channel bottom rather than by raising the water surface. This method was used in the Willwood Dam, as shown in Fig. 2-K (*ENR*, Oct. 27, 1927, p. 660).

On rock foundations where the tailwater level is nearly high enough to cause the jump to form, experience indicates that if no protection is added downstream from the bucket of the dam, the bottom will be scoured out until sufficient depth is provided to permit the jump to form, and no further scour will take place (*Civil Engineering*, March, 1931, p. 527).

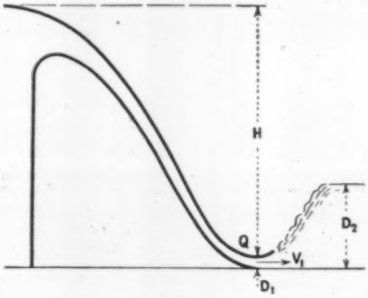


FIG. 3—FACTORS to be considered in computing the hydraulic pump below an ogee dam.

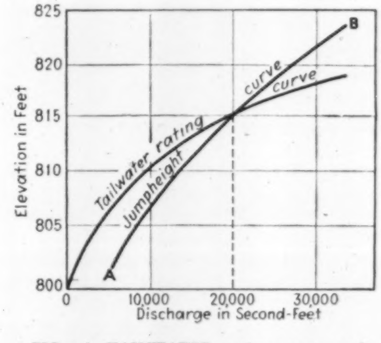


FIG. 4—TAILWATER rating curve and curve of jump height for a typical dam.

Class 2

Dams in the second class are apt to occur where the foundation rock is at a considerable depth and where the tailwater surface is therefore higher than necessary to form the jump. This case will be more frequently encountered in the future than in the past, due to the exhaustion of the supply of good dam sites. Under these circumstances, if an ogee dam with conventional bucket is used, the water flowing down the face of the dam dives under the tailwater and travels at high velocity a long distance along the bottom, forming only a very imperfect jump. The more nearly the tailwater depth corresponds to the depth required to form the jump, the shorter the distance which the high velocities extend downstream. A perfect jump could be formed for any discharge by building a level apron below the dam to give just the correct depth for the formation of the jump, but this apron would probably not be at the correct elevation for other discharges. By making the apron sloping, the various depths required for the different flows can be provided. The high-velocity stream flows down the sloping apron until the depth below tailwater level is reached, at which the jump can be formed for that discharge, and at this point the jump occurs. The advantages of the sloping apron have been pointed out by G. Gale Dixon in *ENR*, May 3, 1928, p. 696.

The formula given above does not exactly apply to jumps on a sloping floor, since the water enters the jump in a direction somewhat different from that in which it flows away, while the formula assumes motion in the same direction.

A jump formed under favorable conditions is an intimate, relatively uniform mixture of air and water with a white appearance, and the velocity is reduced within a comparatively short distance. As the jump becomes less perfect the mixture is not so intimate, and the velocity is not so rapidly reduced. It is questionable if a perfect jump can be formed except on a level floor. As the slope of the floor is increased, the dissipation of the energy becomes less efficient. Experiments on the model of the Cle Elum Dam spillway with floor slopes of 1½ horizontal to 1 vertical, 2:1, 3:1 and 4:1 showed progressively less scour as the slope was flattened.

Probably the outstanding example of the use of the sloping apron for dams in the second class is the Madden Dam (Fig. 2-L), recently built to store water for the Panama Canal. The form used there was developed as the result of extensive model tests (*ENR*, July 14, 1932, p. 42).

The height of the natural tailwater and the jump-height curve for an apron at streambed level, as revealed by the Madden Dam model studies, are given in Fig. 7, showing that this case falls into Class 2. The shape of the apron was determined by trial. By varying the tailwater level a determination was made for each form of apron tested of the tailwater levels required for the various discharges, to cause the jump to form at the upstream edge of the apron. For each form a curve was plotted of tailwater level required against discharge over the dam. The agreement of this curve with the tailwater rating curve for the best apron developed is shown on Fig. 8. The apron developed had a slope of 4 horizontal to 1 vertical, with its upstream edge approximately 30 ft. above the foundation level. At large discharges, however, the high velocities extended entirely across the apron, and a small triangular sill or lip was placed on the downstream edge of the apron to deflect the swift water up off the streambed. The sloping apron generally may call for an increase in the volume of concrete, but in the case of Madden Dam this will be of assistance in resisting earthquake effects.

In the model experiments for the Madden Dam another form was investigated which requires less concrete and would prove advantageous in certain conditions. It may be called the high-bucket type. It consists of the ordinary curved bucket of the ogee

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**Transactions*, Am.Soc.C.E., Vol. 93, 1929, p. 487. *ENR*, Nov. 11, 1926, p. 800. "Hydraulic Laboratory Practice," Freeman, p. 506. *International Engineering Congress*, Vol. II, 1915, pp. 46-63.

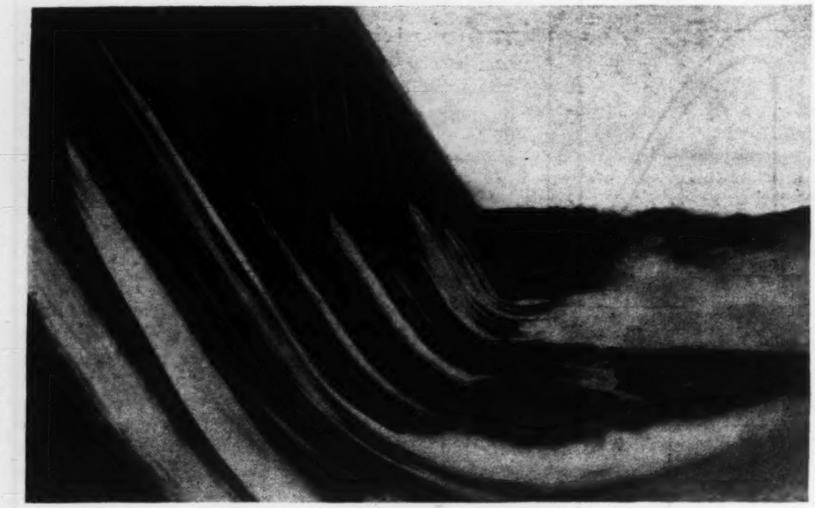


FIG. 5—AT CONOWINGO DAM an upward curving apron on the dam throws the jet into the air to fall harmlessly over a wide area of water some distance away from the structure.

weir located some distance above the river bottom, as shown on Fig. 9-A.

When the tailwater level is somewhat higher above the lip of the bucket than the upper surface of the high-velocity sheet at the end of the bucket, any water that might be on top of this sheet is swept away by friction with this sheet, and the upper surfaces of the sheet are below the tailwater level. A pressure is then exerted on the under side of this sheet beyond the lip of the bucket, as shown by the arrows in Fig. 9-A, due to the pressure exerted upstream beneath the sheet from the higher tailwater level. The high-velocity jet is deflected upward by these forces in a great sweep which may carry it even higher than the tailwater level, to which it falls back after the upward motion is overcome by gravity. As this water falls on top of the deep tailwater it does no damage to the river bottom, and the only scour on the bottom is that due to the upstream flowing water of the eddy that forms beneath the high-velocity sheet. This condition of flow occurs at flood times on the dam (Fig. 2-M) of the recently completed Dnieprostroy power plant on the Dnieper River in Russia (*ENR*, June 23, 1932, p. 877; July 21, 1932, p. 90; *Reclamation Era*, January, 1933, p. 7).

For somewhat higher tailwater levels the path of the high-velocity sheet tends to become nearly vertical, and part of it falls back into the valley along the face of the dam, as shown on Fig. 9-B. This acts as a brake on the high velocity sheet, and it does not sweep so high. The energy in this case is very thoroughly dissipated without attacking the streambed.

On the Madden Dam model the height of tailwater that would give these conditions for a bucket lip at El. 90 was determined for the entire range of discharge. These tailwater heights were plotted against discharges and were found to be approximately parallel to the tailwater rating curve of the river, as shown on Fig. 10; that for condition A was roughly 3 ft. below the tailwater curve of the river, and that for condition B approximately 5 ft. above. By lowering the bucket 5 ft. the A curve would approximately coincide with the tailwater curve of the river, and a rise of 3 ft. in the bucket would bring the B curve into agreement. Thus, with a bucket at El. 85, the A condition would occur at all discharges, while at El. 93 the B condition would occur at all discharges.

For the conditions at the Madden Dam, assuming the riverbed material to be sufficiently fine to be moved by the back eddy, these relations were found to be unstable, as the back eddy carried the fine material up toward the bucket and tended to build up a bar there, which cut off the back pressure from the tailwater and caused the high-velocity sheet to flow more nearly horizontal. In this position the high-velocity sheet tended to carry along with it all the water in the eddy below it and built up a low-pressure area at A of Fig. 9-C in place of the eddy. The force of the tailwater pressure then acted on the top side of the sheet and deflected it downward against the bottom, which it struck with a considerable impact. With a bottom composed of solid rock or material of too large a size to be moved by the back eddy, the condition which has been outlined would not occur.

It is believed that these flow conditions offer a method of scour protection below dams worthy of serious consideration for the condition of deep tailwater below overfall dams. Their appearance is not as satisfactory as the hydraulic jump on the sloping apron, but they require much less concrete than the sloping apron, and if the condition C can be avoided they bring even less scour on the bottom. In the Madden model the lip of the bucket was horizontal. If it was curved up somewhat as on the Dnieprostroy Dam, it is probable that the C condition would be less likely to occur. It is not necessary to have only one of the two satisfactory conditions throughout all discharges, as one might be used for low flows and the other for high ones. This will often

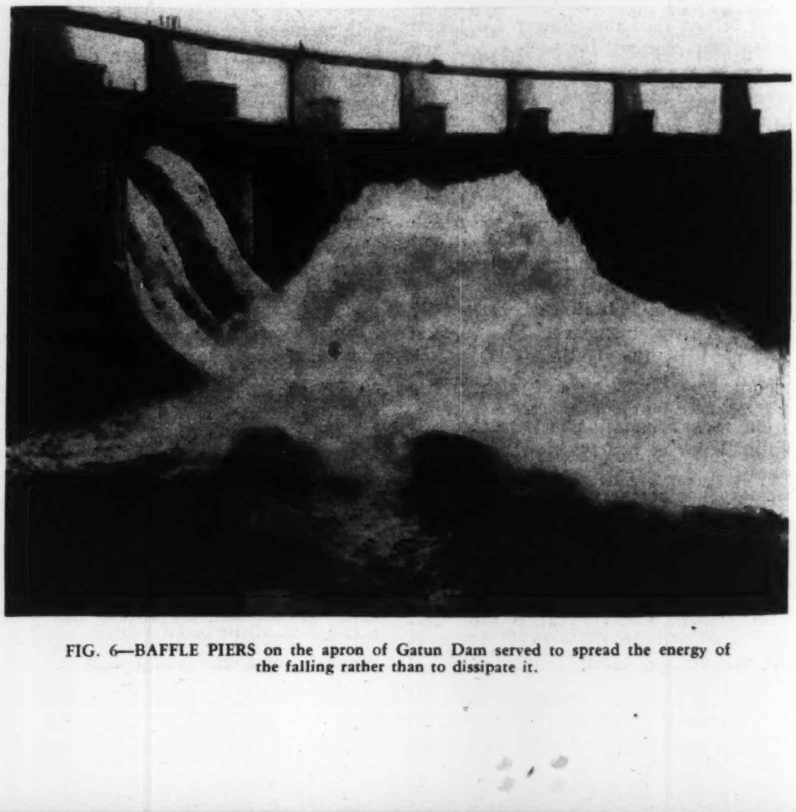


FIG. 6—BAFFLE PIERS on the apron of Gatun Dam served to spread the energy of the falling rather than to dissipate it.

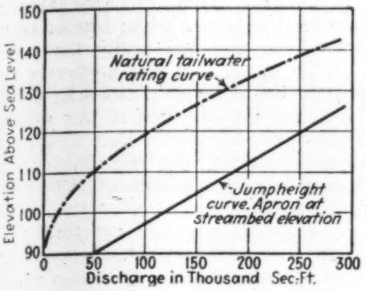


FIG. 7—RELATION of tailwater level to hydraulic jump when the apron is at streambed, as shown by the Madden Dam model studies.

permit the matching of the river tailwater curve when it cannot be done with either one alone.

The conventional bucket with relatively short horizontal apron may be satisfactory for class 2 conditions if the jump-height curve (based on the apron level) is not too far below the tailwater rating curve, since the proper depth to form the jump may be reached on the slightly sloping portion of the bucket and a relatively perfect jump would be formed. If the difference between the two curves is great, the depth causing the formation of the jump will be reached on a steeply sloping surface in the bucket or on the steep face of the dam, and the jump would be very imperfect, with high-velocity currents extending far downstream, necessitating a long apron. The length of the apron may be considerably shortened by the use of some forms of sill at its downstream end.

Class 3

The third class occurs where the tailwater depth at low discharges is insufficient to cause a jump to form on a level apron at river-bottom level, but is more than sufficient at high discharges. This is a common case, and the solution consists in artificially creating enough water depth to make the jump form on the apron at low discharges. This may be done by a low secondary dam or sill across the channel near the downstream end of a level apron. This secondary dam must be high enough to cause the hydraulic jump to form upstream from it for all flows for which the natural tailwater depth is insufficient. It may need a secondary apron downstream from it, for it is in fact just a second dam. The depth required may also be secured by depressing the apron, preferably by sloping it downward in a downstream direction. This method was used on the repair of the Hamilton Dam (*ENR*, Jan. 28, 1932, p. 130).

This third case is usually favorable to the use of baffle piers or some form of dentated sill near the end of the apron, as these tend to break up the high-velocity flow at low discharges and also to raise the tailwater, both of which actions promote the formation of the jump. They would also be advantageous at high flows, since then the depth of tailwater is greater than is required to form the jump, and the nappe over the crest tends to dive down to the bottom of the river and flow along the apron at high velocity, as previously described. When this condition occurs, the sills or piers are useful in breaking up this destructive current. For low intake dams it is not uncommon to have the height of tailwater at high flows sufficient to submerge the entire dam. In such cases the drop at the dam is slight, and protection against these high flows is no problem.

Class 4

The fourth class, where the tailwater depth is sufficient at low flows but too small at high flows, can be solved by increasing the depth of tailwater sufficiently to cause the jump to form for the maximum discharge contemplated, either by a secondary dam or an excavated pool. With these facilities of the magnitude required for the maximum flow, the tailwater depth would be more than sufficient to cause the jump to form on the apron at the lower flows, but this condition would probably not be objectionable for low flows.

Changes in dam-crest length

To make the foregoing analysis as readily understandable as possible, it has been assumed that the streamflow was uniformly distributed over a fixed length of the dam, and therefore for a given discharge there would be a fixed condition of overflow and a fixed tailwater elevation. By the proper selection of crest length, however, it may be possible to secure a closer agreement between the tailwater rating curve and the jump-height curve than is secured by an arbitrarily chosen length. If the first assumed length produces a class 1 condition, the agreement will be improved by increasing the crest length, which will cut down the discharge per foot of length and consequently lower the jump-height curve. Similarly, a class 2 condition can be improved by decreasing the crest length, producing a greater discharge per linear-foot of crest and thus raising the jump-height curve. Such changes may result in increases in the cost of crest gates or other features of the dam, but this might be much more than offset by the reduced cost of bottom protection, and the possibilities of such a saving would justify a study of this phase where the circumstances permit a choice of crest lengths.

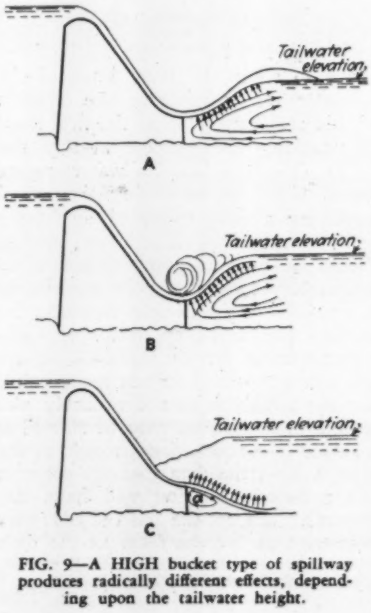


FIG. 9—A HIGH bucket type of spillway produces radically different effects, depending upon the tailwater height.

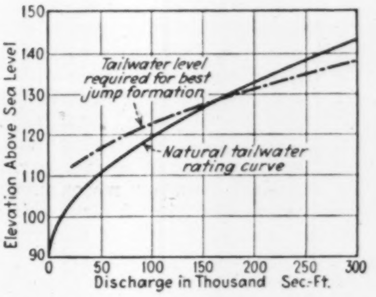


FIG. 8—THE CURVE of tailwater level required for the best hydraulic jump formation on the apron of the design adopted for the Madden Dam spillway lies close to the curve of natural tailwater rating.

Use of crest gates

The foregoing analysis has also been simplified by assuming that the flow of the stream was uniformly distributed over the entire crest length of the dam. With control gates on the crest, however, the flow can be concentrated, and at certain portions of the dam the flow will be greater than at others. To be perfectly safe, the protection should be designed so that it will be sufficient with any possible condition of gate openings and flow. As a practical matter, however, it may be assumed that reasonable judgment will be used in operating the gates, and sufficient protection provided so that no severe damage would result with the undesirable conditions acting for a limited time such as might occur, for example, in the case of the failure of a gate to close when desired. In most cases it will be found best to have the crest gates designed to be capable of operating partly open, in order to distribute the water uniformly over the crest instead of permitting only an entirely open or entirely closed condition.

The foregoing classification applies principally to protection below masonry overfall dams of the types commonly used in this country. For the broad weirs with slightly sloping aprons frequently used in India and Egypt, a somewhat different analysis is necessary. The oldest form of this type of weir consists of a pile of loose rock, with or without masonry dividing walls, having a sloping upper surface paved with hand-laid rock or masonry, as shown on Figure 11. After passing over the crest of a weir of this type, the water flows down the sloping apron until it encounters the tailwater, and at this point a hydraulic jump is usually formed. To prevent scour, this jump should form far enough from the downstream end of the apron that the turbulence of the jump does not reach to the unprotected riverbed. To secure this result may necessitate the extension of the apron below the natural level of the riverbed. It is necessary, or at least desirable, to have the point where the jump occurs move up the apron as the discharge increases, since this provides a longer length of apron to take care of the greater turbulence of the jump with the larger flows. It is also an advantage if the weir is entirely drowned out for very high flows, since this eliminates the combination of high discharge and fall which would produce so much destructive energy. These conditions exist at the Rosetta Weir (Fig. 11), which is at the head of the delta of the Nile ("Standing Wave Weirs," by A. D. Butcher). The surface profiles show that the position of the jump moves upstream as the discharge increases, and for a flow of 170,000,000 cu.m. per day the jump is entirely drowned out. Although for many dams of this type the maintenance cost has been high, when conditions are favorable it may be very low, as indicated by the maintenance charge of 0.4 per cent for a 15-year period at the Laguna Dam on the Colorado River (*New Reclamation Era*, December, 1924, p. 189), all of which was due to a cutoff of the river just downstream from the weir, which lowered the tailwater level 7 ft. and necessitated an extension of the apron.

With this type of weir the possibilities of increasing the tailwater depth are rather limited. It is therefore unsuited to conditions having a low tailwater level, and two complete failures are believed to have been due to tailwater levels so low that the hydraulic jump occurred too near to or below the downstream edge of the masonry, causing an undermining of the structure which progressed upstream and caused a breach. An adjustment of the dam to fit the tailwater conditions may sometimes be made by a proper choice of the dam length, as was previously discussed.

Most of the recent dams of this type in India and Egypt have been constructed with broad sloping masonry aprons surmounted with piers and stoney gates. The foregoing discussion applies to this kind also, although it is complicated somewhat by the necessity of having sufficient tailwater depth to cause the jump to form on the apron with the gates in a partly open condition. To secure this, it may be necessary to carry the apron below natural bed level. If the river carries much bed load, allowance should be made in computing the position of the jump for a retrogression of the downstream river level, as discussed in *ENR,* June 28, 1934, p. 836.

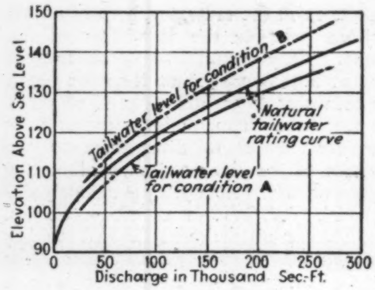


FIG. 10—TAILWATER LEVELS determined in test on Madden Dam spillway models with the bucket at El. 90.

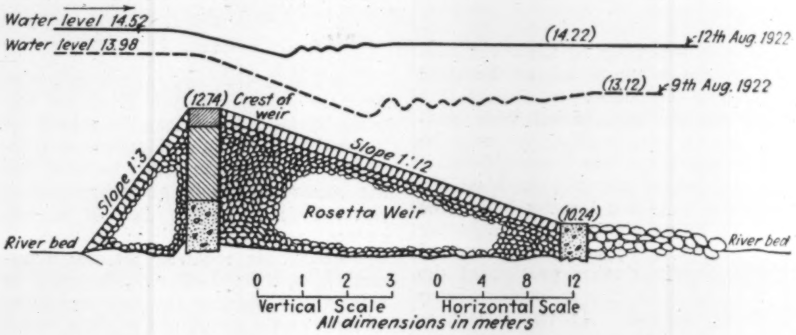


FIG. 11—ROSETTA WEIR at the head of the delta of the Nile River is typical of the rockfill sloping-apron type of weir used commonly in Africa and India.

Tailwater rating curves

Enough has been given in the foregoing to show the importance of the tailwater rating curve in the solution of this problem. One of the first steps in attacking the problem at any site is to determine the tailwater rating curve, either by observing the actual levels for a wide range of discharges or by computation. The former method should be used if possible, but fairly satisfactory results may be secured by determining the tailwater elevation for various discharges by means of backwater curves for these flows. Since the water levels at downstream points for these discharges are probably also unknown, the curves may be started at assumed elevations far enough downstream from the dam that the error in the assumed elevation will have disappeared before the curve has been computed as far upstream as the dam. That this is the case may be determined by assuming somewhat different elevations for the same discharge at the lower end of the stretch; and if both assumptions give practically the same elevation at the dam site, any error by an incorrect assumption is negligible.

It is not the intention of this article to give the impression that hydraulic laboratory tests are unnecessary in working out the best form of scour protection below dams. Such tests should be made on all important structures and will usually pay for themselves in the improvements which they bring about in the minor features of the design, entirely aside from the major improvements which they make possible. The intention of this analysis is only to point out the lines along which the best solution probably lies, in order that effort may not be wasted.

All the design studies of the U. S. Bureau of Reclamation referred to in the foregoing were made under the direction of J. L. Savage, chief designing engineer. All engineering and construction work is under the general direction of R. F. Walter, chief engineer, Denver, and all activities of the bureau are under the general charge of Elwood Mead, Commissioner, Washington, D. C. R. R. Randolph, assistant engineer (Panama Canal) was in resident charge of the Madden Dam model studies.

State Engineering Department Proposed in Maryland

Establishment of a state department of engineering for Maryland is provided in a budget for the 1936-37 bienneum, which has been submitted to the general assembly by Governor Harry W. Nice. Legislation to effect the creation of this department will be introduced, and the budget item of $25,000 per year has been made by the governor to cover the work.

According to the governor, the duties of the department would be to make a comprehensive survey of all state properties, compile accurate statements of the physical condition of buildings and supervise the installation of mechanical equipment and improvements to structures.

A Rapid and Concise Method of Analyzing Rigid Viaduct Bents

By L. C. Maugh
Assistant Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich.

THE ANALYSIS of a rigid-frame bent of the type shown in Fig. 1a, which is sometimes used in rigid viaduct construction, is very similar to the solution of a Vierendeel truss. A very simple and direct method of solution for the latter structure was presented by Prof. K. Calisev at Zagrebu, Yugoslavia, in a dissertation on "Solution of Vierendeel Systems by Successive Approximations." In this method, each panel of the frame, as *abcd,* was first analyzed as an independent structural unit, and afterwards a correction was made for the restraining effect of the adjacent panels. In this article the writer has retained these basic assumptions but has modified the method of applying them so as to reduce the number of steps in the solution and arrange the formulas in a more convenient form.

In order that each panel will act as a separate structure, it will be considered as a rigid frame that is hinged to the remaining portion of the structure. Thus, the panel *abcd*, Fig. 1b, will be subjected to the forces shown, in which V is the external shear in the panel and M is the bending moment at the section *ab*. The rigidity factors I of the columns are both taken equal to K, while those for the horizontal struts are designated by K_1 and K_2. The moments at the ends of the columns in the panel *abcd*, which is typical of any panel, can be obtained from the following formulas:

$$M_{ad} = M_{bc} = \left(\frac{\alpha M - VL}{2}\right)\left[\frac{3 + s + \alpha(2 + s)}{D}\right] \qquad (Ia)$$

$$M_{da} = M_{cb} = \left(\frac{\alpha M - VL}{2}\right)\left[\frac{3 + r\alpha}{D}\right] \qquad (Ib)$$

in which $r = \frac{K}{K_1} \qquad s = \frac{K}{K_2}$

$$\alpha = \frac{h_2 - h_1}{h_1}$$

and $D = 6 + r + s + \alpha(2\alpha + \alpha s + 2s + 6)$

These moments, which will be called the *primary moments,* can be computed for each panel and tabulated on a sketch of the structure. The equations are expressed so that positive moments are clockwise and negative moments counterclockwise. However, the directions of the end moments can be determined by inspection for any specific case. It can be seen from the above equations that the inclination of the columns will greatly reduce the bending moments, particularly when most of the load is applied at the top.

The restraining action of the adjacent panels will now be considered by analyzing the effect of moments applied to the panel *abcd* in the manner indicated by Figs. 1c and 1d. These diagrams show the moments m' and m'' which exist in the panels below and above the panel *abcd* and which represent the restraining action at the joints. The end moments in the panel *abcd* produced by m' and m'' will be the required corrections and will be called *secondary moments.* These secondary moments can be computed by the following formulas:

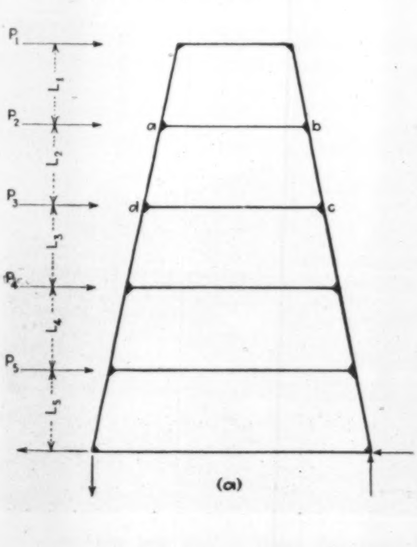
$$\Delta M_{ad} = \Delta M_{bc} = -\frac{s(1 + \alpha)}{D} m^1 + \frac{r}{D} m'' \qquad (IIa)$$

$$\Delta M_{da} = \Delta M_{cb} = \frac{s(1 + \alpha)^2}{D} m' - \frac{r(1 + \alpha)}{D} m'' \qquad (IIb)$$

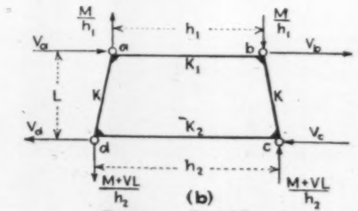
It will be noted that m' and m'' have been taken with positive sign when acting clockwise on the panel, and that the sign of the end moments is the same as before. The corrections due to either m' and m'' can be recorded separately on a sketch of the structure.

The application of the above equations is illustrated by a numerical example in Fig. 2. This bent was analyzed by Mr. C. R. Grimm in his description of the Kinsua Viaduct (*Transactions, Am. Soc. C. E.*, 1901, Vol. 46), so that a comparison can be obtained with the method of least work. In both solutions the effect of the change in length of the members has been neglected. The first step in the solution was to tabulate the values of M, V, r, s, and D for each panel on a sketch of the structure, Fig. 2. Next, the primary moments in each panel were computed by means of formulas *(Ia)* and *(Ib)* and recorded

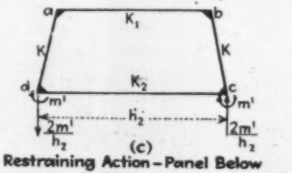
FIG. 1—FORCES to be considered in first assuming each panel as a rigid frame that is hinged to the structure at its four corners and then applying a restraint factor.


P1
P2
P3
P4
P5
L1
L2
L3
L4
L5
a
b
d
c

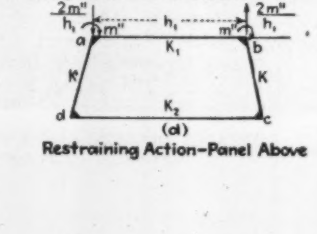
(a)


M/h1
h1
M/h1
Va
a
b
Vb
K1
L
K
K
Vd
K2
Vc
d
c
h2
M+VL/h2
M+VL/h2

(b)
Forces on Rigid Panel


a
K1
b
K
K
K2
d
m'
c
m'
h2
2m'/h2
2m'/h2

(c)
Restraining Action – Panel Below


2m''/h1
h1
2m''/h1
m''
m''
a
K1
b
K
K
d
K2
c

(d)
Restraining Action – Panel Above

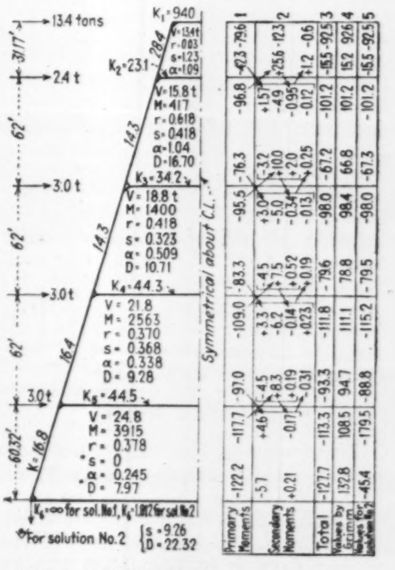

13.4 tons
3'11.7'
2.4 t
62'
3.0 t
62'
3.0 t
62'
3.0t
60.32'
K1=9.40
K2=23.1
28.4
V=13.4t
r=0.03
s=1.23
α=1.09
V=15.8 t
M=417
r=0.618
s=0.418
α=1.04
D=16.70
14.3
K3=34.2
V=18.8 t
M=1400
r=0.418
s=0.323
α=0.509
D=10.71
14.3
K4=44.3
V=21.8
M=2563
r=0.370
s=0.368
α=0.338
D=9.28
16.4
K5=44.5
V=24.8
M=3915
r=0.378
*s=0
*α=0.245
*D=7.97
K=16.8
K6=∞ for sol. No.1, K6=1.812 for sol. No.2
*For solution No.2 {s=9.26 D=22.32
Symmetrical about C.L.
Primary Moments
Secondary Moments
Total
Values by Grimm
Values for solution No.2
-122.2 -117.7 -97.0 -109.0 -83.3 -95.5 -76.3 -96.8 -42.3 -79.6
-5.7 +4.6 -4.5 +3.3 -4.5 +3.0 -3.2 +15.7 +25.6 -12.3
+8.3 -6.2 +7.5 -5.0 +10.0 -4.9
+0.21 -0.17 +0.19 -0.14 +0.52 -0.34 +2.0 -0.95 +1.2 -0.6
-0.31 +0.23 +0.19 -0.13 +0.25 -0.12
-127.7 -113.3 -93.3 -111.8 -79.6 -98.0 -67.2 -101.2 -15.5 -92.5
132.8 108.5 94.7 111.1 78.8 98.4 66.8 101.2 15.2 92.6
-45.4 -179.5 -88.8 -115.2 -79.5 -98.0 -67.3 -101.2 -15.5 -92.5
1
2
3
4
5

FIG. 2—SOLUTION of moments in a bent by short-cut method of successive approximation, with comparison of values from method of least work (Grimm).

in row 1. These primary moments were then used in formulas *(IIa)* and *(IIb)*, to obtain the secondary moments or corrections that are given in row 2. The corrections were made by going from top to bottom and then back as shown by the arrows. This first set of corrections can then be used to obtain additional corrections, although in general these will be very small. The sum of the primary and secondary moments gives the final result as recorded in row 3. It will be noted that in this first solution the rigidity of the bottom strut is taken equal to infinity, which is equivalent to the fixed end condition that Mr. Grimm assumed. The values of the moments that were obtained by Mr. Grimm are given in row 4. The moments recorded in row 5 were computed by using the actual rigidity of the bottom strut and by assuming the base of the columns as hinged. Because of the unknown restraint at the column base, the actual moments will be between these two results.

Light Welded Steel Frames for Dormitory Buildings

Two-story dormitories at Stanford University represent new design intermediate between wood and structural steel—Rigidity, speedy erection, low cost and low insurance rate were design considerations

By J. B. Wells
Associate Professor of Civil Engineering, Stanford University

WELDED steel frames of light weight, representing a new type of building construction, have been used in a group of dormitory buildings recently erected at Stanford University. The novel feature of the design is the use of steel members in thicknesses, for the most part, of only $\frac{1}{16}$ or $\frac{1}{8}$ in. The light sections are made up into rigid members and panels, using arc-welding for connections at joints and all intersections. The building units, such as studs and joists, are closely spaced very much as in wood construction. The resultant structure has much more rigidity than could be had with ordinary wood construction, is fire and termite-resistant, obtains a low insurance rate, and offers these advantages at a cost much less than would be entailed by structural steel or reinforced concrete. In short, it is an intermediate type of construction. Five buildings are included in the group, a one-story kitchen 55x67 ft. in plan and four two-story dormitories, two of which are $42\frac{1}{2}$x156 ft. in plan and two $42\frac{1}{2}$x209 ft. in plan. In the following is given a description of the frame of one of these intermediate-type structures.

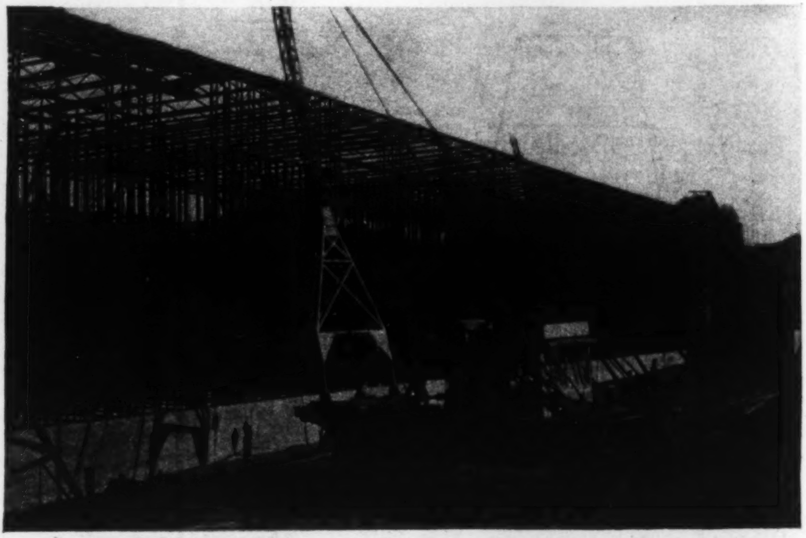
Structural details

There are four longitudinal walls extending the full length of each dormitory, two exterior walls and two corridor walls, 7 ft. apart, which form a central hallway. All exterior studs extend in one piece from foundation to eave line, and all corridor studs extend unbroken from foundation to the ceiling line of the second floor. The lower ends of all studs are welded to a $\frac{1}{4}$-in. steel-plate sill, 6 in. wide for outside walls and 4 in. wide for corridor walls, secured to the concrete foundation by anchor bolts with double nuts, a detail which permits very close setting of the sill to its proper elevation.

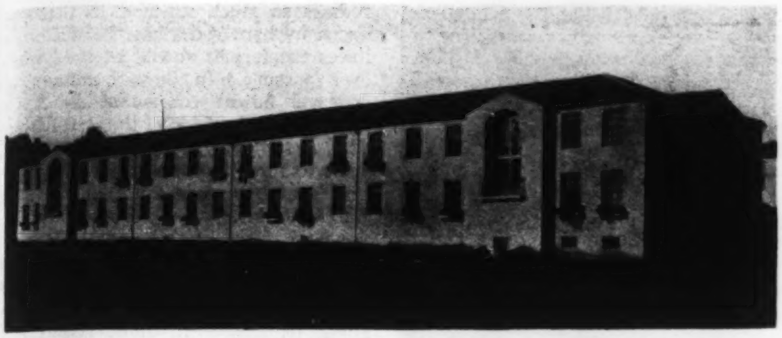
After the sill has been adjusted to its proper level, the space between it and the concrete foundation is filled with cement mortar. The exterior studs are 22 ft. 3 in. long by 6 in. deep and are of trussed construction. The chords or flanges are made up of a special section, and the web members consist of a continuous $\frac{3}{4}$-in. channel, bent to form a continuous diagonal trussing member that is fillet-welded to the chords at points of intersection. Studs are spaced approximately 17 in. c. to c. Stud tops are held in place by a continuous channel pressed from 16-gage material, whose flanges fit down over the stud flanges and are welded thereto. Corridor studs, which are of two types, are 4 in. wide. Where transverse room partitions intersect the corridor walls, the studs used have the same details as the exterior studs except that they have a width of 4 in. All other studs in the corridor walls are 4-in. channels with 1-in. flanges, pressed from 16-gage steel.

Joists are 12 in. deep, employ Warren truss construction, are spaced approximately 34 in. c. to c. and extend entirely across the building in one continuous piece. The chords are of angle sections varying from $1\frac{1}{4}$x$1\frac{1}{4}$x$\frac{1}{8}$ in. to 2x$1\frac{1}{2}$x$\frac{1}{8}$ in., the chord size depending on the load which the joist is to carry. Web members of these trussed joists are 1x1x$\frac{1}{8}$-in. angles, fillet-welded to the vertical legs of the chord angles. These joists are somewhat unusual because both chords extend from outside wall to outside wall, whereas in many types of steel joists it is customary either to bend up the lower chord or to cut it off some distance from the end. The truss type of joist used on the Stanford dormitories gives a much more rigid connection between the wall frame and the joist than could be obtained if only one chord extended to the wall. Both upper and lower chords of these truss joists are arc-welded to both vertical members of the exterior studs and to the flanges or webs of the corridor studs. Typical welding details are shown in the accompanying drawing.

The wood floors are supported by 2x4-in. nailing strips spaced 17 in. c. to c., which in turn are fastened to the upper chords of the steel floor joists by metal clips. The first floor consists of one lower layer of 1x8-in. boards laid diagonally, over which is laid the hard-



PORTABLE DERRICK erecting prefabricated wall panels of light steel members in new Stanford dormitory.



DORMITORY BUILDING at Stanford University, which utilizes light welded steel frame covered with paper-back welded wire fabric and stucco.

wood floor in the rooms and the fir floor in the corridors. A layer of building felt is placed between the two thicknesses of wood flooring. The second-story floor is similar to the one below except that a ½-in. layer of sound-deadening material is placed between the sub- and finish floors.

The roof consists of tile on wood sheathing, which is nailed to 2x4 wood rafters spaced 21 in. c. to c. Steel clips welded to longitudinal angles secure the rafters in place. The longitudinal angles are supported by six lines of steel posts running the entire length of the building. The two center lines of posts are supported directly by corridor partitions; and the two outer lines on either side of the center are supported at the third-points of the second-floor ceiling joists.

The building frames are designed for a live load of 40 lb. per sq.ft. in rooms and 100 lb. per sq.ft. in corridors and on stairs. In addition to this, to provide for earthquake stresses, the frames are designed to sustain a lateral force equal to 10 per cent of the mass of the structure plus 10 per cent of the live load applied either longitudinally or transversely. Although welding the floor joists to the studs makes for a rigid frame, entire dependence was not placed on this connection, and diagonal braces were welded to the frame extending from the eave-line to the sill. In corridor and longitudinal walls, where these braces cross studs, they are welded to them at each intersection. These braces are 1½x⅛-in. flats from the eave line to the second-floor line and 2x⅛-in. flats from the second-floor line to the sill. Practically all partitions between rooms contain X-bracing consisting of flats of corresponding sizes. These braces are welded to the frame at their ends and where they intersect, but are not welded to the light metal studs that carry the lath and plaster.

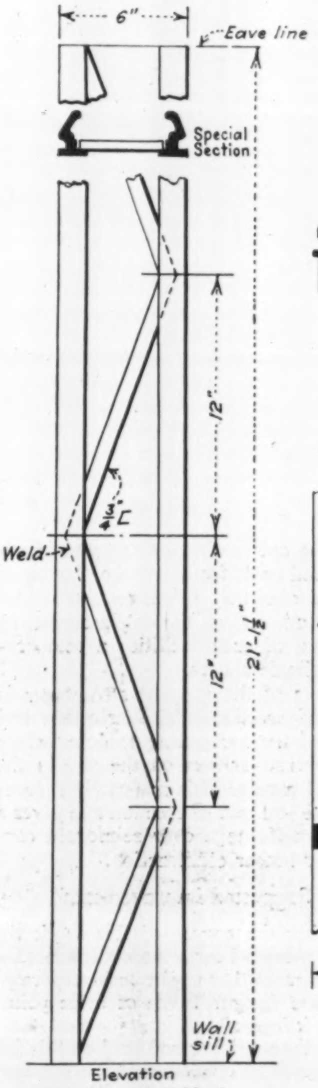
Fabrication and erection

Both the exterior and corridor studs were assembled in the shop, together with door and window-opening details, and welded in panels two stories high by approximately 10 ft. long. These panels were transported to the building site by motor trucks and special trailers. Completeness of this shop fabrication greatly simplified field erection, which consisted of merely raising the panels into position by means of a light power-driven boom derrick mounted on a truck. After a series of wall sections had been erected and stayed, floor and ceiling joists were swung into position and welded, thus tying the whole frame together. Horizontal girt angles provided a temporary support for the second-floor joists until they were welded to the studs. Steel frames for the four dormitory buildings were placed in position and completely welded in 30 working days; the erecting crew worked one shift, and the welding crew worked two shifts each day, which is an indication of how speedily this type of building frame can be erected.

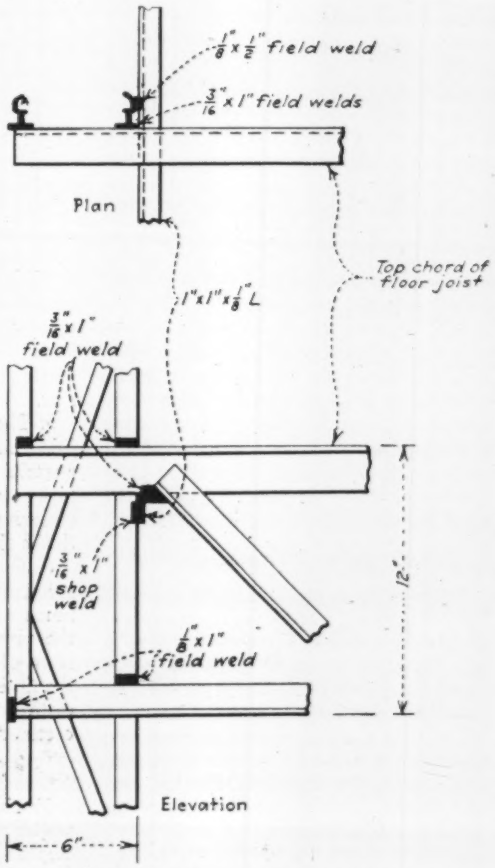
All welding was done with a 3/32-in. rod, using a current of approximately 190 amp. at the generator and 160 amp. at the work. In designing the welded joints a working stress of 1,000 lb. per linear-inch was used as the allowable load on ⅛-in. fillet welds. Such a working stress is quite conservative, as practically all test specimens made during the progress of the work showed an ultimate strength of 5,500 to 6,500 lb. per linear-inch of ⅛-in. fillet weld.

The exterior walls of the steel frames

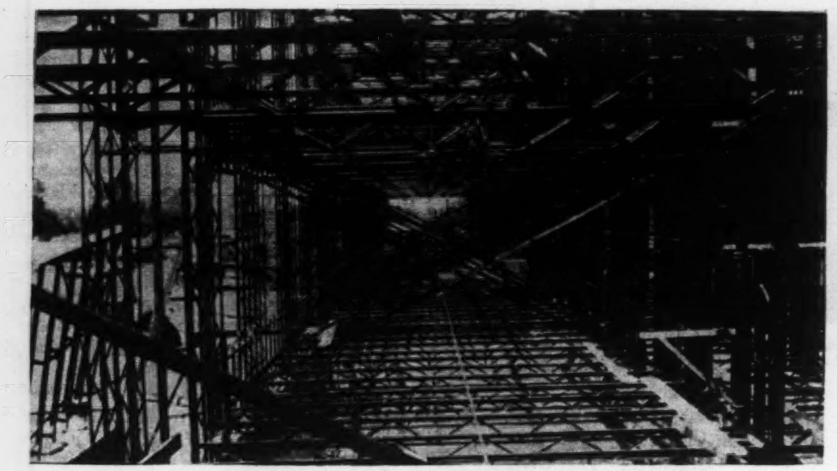
TYPICAL DETAILS of steel frame used for two-story dormitory.



Exterior Wall Stud



Connection of Second Floor Joist to Exterior Stud



VIEW down row of first-floor rooms. Below are first-floor joists, above are second-floor joists, at left are outer-wall studs, to the right are corridor studs, and in the center are transverse braces for partition walls.

are covered on the outside by a paper-back, welded wire fabric with a 2x2-in. mesh of 16-gage wires and are fastened to the studs by 16-gage tiewires spaced 6 in. on centers. The exterior stucco is applied directly to this fabric. Interior walls and partitions are covered with a reinforced, expanded metal lath, although for small closet partitions and vaulted ceilings of hallways plain expanded metal lath is used. All metal lath is wired to steel studs or small furring channels. The ceiling of the first floor has a layer of sound-deadening board approximately 1 in. thick suspended from the channel furring strips. Plaster was applied directly to this material, although in some buildings a layer of 1-in. mesh poultry netting was fastened to the sound-deadening board to give the plaster a better bond.

All steelwork was sprayed in the shop with a coat of red lead; after field-welding, all welds were given a brush coat of red lead, and then the entire steel frame received a spray coat of black graphite paint. With these protective coatings there is little danger of corrosion in a frame so completely protected from the weather.

Advantages in intermediate field

From the cost standpoint, these buildings represent a type of construction which the writer believes to be suited to the intermediate field between wood frames and either reinforced concrete or structural steel.

Building frames of this intermediate type probably will come into more general use on the Pacific Coast for one- and two-story buildings, because of the following advantages:

1. They are decidedly more fire-resistant than wood frames. While the wood used for floors, sheathing, doors and other items prevents these buildings from being rated as fireproof, nevertheless their insurance rate is materially less than on corresponding wood-frame structures, either with or without a sprinkler system.

2. These frames are capable of analysis when considering lateral forces such as occur during earthquakes. The joints are of definite strength, whereas in some other types of construction the strength of the joints between intersecting members is questionable.

3. Termites, which are becoming an increasing hazard to wood structures throughout California, obviously cannot attack the main steel frame, and it is believed that there will be little likelihood of these insects attacking the wood floors or roof sheathing.

4. Shrinkage, one of the annoying problems of the architect and builder, will not occur in these frames. Although they will expand and contract slightly with changes in temperature, provision is not required for shrinkage as ordinarily recognized in timber construction.

5. The open-web construction of both joists and studs facilitates the placing of electric conduits, drainage and water pipes and makes the replacement or changing of such facilities a comparatively simple matter.

6. One of the greatest advantages is speed of erection. All fabrication and much of the assembling is done before the material arrives on the site in the form of panels. This materially reduces the time and cost of erection and gives a distinct advantage over reinforced concrete or timber construction.

Suggested improvements

During the course of this work the writer observed certain opportunities for improvement that might be incorporated in future design. Some of these points are as follows:

The bare welding rod used on this job gave excellent results, as shown by tests. However, the weld produced by covered rods is so much superior to that produced by bare rods that the writer believes the former should be used wherever possible. In these buildings the diagonal braces consist of $\frac{1}{8}$-in. flats welded on the outside of the stud flanges. This detail proved somewhat troublesome to the plasterers, especially where braces crossed each other, thus making a total thickness of $\frac{1}{4}$ in. projecting beyond the faces of the studs. With the trussed type of stud it should be possible to place the bracing inside the wall, carrying it through the openings in the studs. If this were done, round rods probably would be easier to handle than flats, and possibly much of the bracing could be welded in place in the shop.

Another detail that could be improved is the fastening of the floor nailing strips to the steel joist. So much depends on the care used by workmen in placing steel clips such as were used on these buildings that there is danger of the fastenings not being driven tight, and as a result squeaks may develop in the floors. A bolt, bent to hook over the joist chord and passed through the nailing strip with a nut and washer on its upper end, would seem to be an effective method of drawing the nailing strip firmly to the joist and holding it in place. A point that is of particular interest to architects and builders is the behavior of the interior and exterior plaster applied to a frame such as this. These buildings have been completed about four months as this is being written, and the absence of plaster cracks on the interior of the buildings is remarkable in view of adverse weather conditions which obtained while this plaster was being applied. On some of the exterior stucco small cracks have appeared, radiating from the corners of some of the window openings. However, most of these could have been avoided, it is believed, by a more judicious use of wire-mesh reinforcing around the corners of wall openings.

The wire mesh used for the stucco and its application to the steel frame could be considerably improved, and the writer believes that this detail should be given much more care and consideration in future construction of this type. The 2-in. mesh used for bonding the stucco is the only paper-backed mesh on the market, so far as the writer knows. Better distribution of reinforcement and greater cross-sectional area of steel could be obtained if 1-in. woven mesh with 16- or 18-gage wires were available as a standard product.

Architectural plans for this group of buildings were prepared by John Bakewell and Arthur Brown, Jr., associated architects. Fabrication and erection of the steel frames were done by the Soule Steel Co., whose engineer, P. I. Baker, supervised the structural design. George Wagner was manager of construction, and Prof. A. S. Niles and the writer were consulting engineers for Stanford University.

Resistance of Creosoted Piles to Borer Attack in Tidewater

Timber with wide sapwood ring, proper air seasoning, maximum impregnation with oil and careful handling, insures long service

AVAILABLE RECORDS on the resistance of creosoted piling and timber to attack from marine borer in tidewater were used as the basis for a comprehensive review of the subject which was presented by Herman von Schrenk, consulting timber engineer, St. Louis, before the annual meeting of the American Wood Preservers Association held in New York, Jan. 22. He concluded that with the use of timber containing a wide sapwood ring, properly air-seasoned and treated with as much good coal-tar creosote as possible, the result is "the most effective structural material for use in pier and wharf construction."

Historic review

Creosote treatment of piling began in the United States about 1875, and in the early years the timber was usually treated green after long periods of steaming. The creosote used was largely imported from England, and both this and the domestic oils were characterized by very high naphthalene content, sometimes 60 per cent or more. The treatment usually consisted of the full-cell process.

At that time decay and marine borers were so rapidly destroying untreated piles and timbers, which rarely gave more than two to five years' service, that creosoting plants increased rapidly in number with a further recognition of value. The service records of many of the old installations are inadequate, but indicate that, taken as an average, the creosoted piles gave service of 30 years or more as compared with the few years available with untreated timber. Among the outstanding early structures was the Lake Pontchartrain trestle, 1884, the Galveston Bay Bridge of the Santa Fe Railroad built in 1875, and the Oakland wharf structure of the Southern Pacific Railroad in San Francisco Bay, treated in 1889. Naturally, there were some failures in the treated piles in these old structures, but on the whole they provided excellent service and more than repaid the cost of treatment.

Type of creosote

One of the important considerations for effective creosoting, reviewed in the paper, covered the question of the proper type of oil to be used. There appears to be no definite information available at present as to the relative effectiveness of low-boiling-point or high-boiling-point elements in the creosote. The general tendency at present is to use a creosote that is higher in the high-boiling-point elements as compared to the material formerly used.

Greatest possible protection is obtained with the thickest ring of preserved wood. For this reason, in connection with the reconstruction work at Boston harbor, specifications require a minimum of 3 in. of sapwood. Incidentally, it is found practical to measure the thickness of the sapwood only at the butt of the pile.

On the subject of preliminary preparation, the author considered thorough air-seasoning most important. The practice of steaming green piles frequently results in the formation of water pockets and the subsequent uneven and irregular penetration of creosote. Because the creosoting process does not so readily affect knots and the adjacent area, it appears advisable, if warranted, to bore out these knots and plug the hole with a piece of creosoted wood.

Insufficient oil retention was considered the source of many failures, and the greatest possible retention of creosote per cubic foot was recommended as well worth the additional cost. For piles in northern waters the recommendation of 20 lb. to the cubic foot was made with this figure increasing in southern waters to the greatest possible retention, commonly known as refusal.

Records of use

Available records on the life of marine structures involving piling and timbers are not as complete as those for creosoted railroad ties, and the resulting conclusion must be more general. One of the difficulties in the review of existing records is the lack of detail on the defective piles. The simple statement that a pile failed and had to be removed, without complete data as to the method of treatment, kind of preservative, condition of service and particularly the type of failure, makes the record difficult to correlate. However, considering average figures and not individual cases, there are thousands of piles which show a service record of 10 to 30 years, and possibly longer. In the replacing of piling for the Galveston Bay Bridge in 1912, 90 per cent of the piling was in good condition after a period of service extending back seventeen years to 1895.

Reference was made to the fact that these earlier installations were treated with creosote, which was relatively higher in low-boiling-point constituents. Investigations have been made to determine the relative effectiveness of these elements, but the results of using various fractions of creosote all show marked differences, and the other factors involved make any general statement relative to the proper composition of the creosote oil difficult at the present time. "With a few exceptions, there are so many gaps in our knowledge that very little of a definite nature can be said as to the relationship between protection, service and the composition of the oil."

Conclusions

"After studying and making personal inspections of creosoted piles the world over, I have come to the conclusion that if piles and timber have a wide sapwood ring, if the piles are clean with no parts of bark adhering, if properly air-seasoned and treated with as large a quantity of oil as it is possible to get into the wood, and that oil does not have too high a per cent of low-boiling constituents, there will be every guarantee of long service." "There has been a tremendous improvement in the character of creosoted piles and timbers due to the increased knowledge and consequent observance of factors which affect the life of creosoted piles, and today it is possible to recommend properly creosoted piles which fulfill the requirements discussed, as the most effective structural material for use in pier and wharf construction." As a conservative estimate of the average life of this material, the writer assumes a figure of 30 years, which he considers to be conservative for the service life of the average pile.

Studies Reveal Principle of Activated-Sludge Action

Recent studies by the United States Public Health Service on the adsorption of organic matter from sewage by activated sludge have led to the definite identification of the adsorbent principle as a base-exchanging substance chemically identical with the zeolites of water purification, according to *Public Health Reports,* Feb. 1, 1935, p. 143. The adsorbent principle is related not to the bacteria themselves, but to the gelatinous matrix or sludge in which they are embedded. The inorganic portion of this matrix is definitely a zeolite. As an example of the similarity of the behavior of activated sludge and zeolite, it is cited that sterilized sludge can be regenerated by sodium chloride. It is also stated that the clotting enzyme has been identified with the sludge zeolite. Detailed information on this new treatment will be contained in a series of papers soon to be published.

Durability of Culvert Types Under Service Conditions

Rating survey of culverts on West Virginia highways brings out important conclusions on preferable design and construction practices

By W. S. Downs
Consulting Engineer, Dept. Highway Engineering, West Virginia University, Morgantown, W. Va.

THE State Road Commission of West Virginia, in cooperation with West Virginia University, has recently completed, under the direction of the writer, a survey of culverts on the state-road system. The object of the survey was to secure information on: (1) durability of the culvert types under actual service conditions; (2) adequacy of design; (3) character of workmanship and general methods of installation; and (4) other data which might lead to better practices in culvert economy. The investigations, therefore, included several types of structures and embraced areas of diverse geographical conditions, with special attention being given to the coal-mining regions. Approximately 4,000 culverts were examined and rated.

In addition to the rating of the structures, attempts were made to seek the causes of failure, attention being given to the soil and topography and the characteristic properties of the drainage water.

All culverts were rated in accordance with a scale of values based upon observed defects that might indicate the successive stages of progressive failure. This permitted numerous comparisons to be made, for diverse service conditions. Some interesting conclusions were reached with respect to the probable service life under the conditions that exist in West Virginia. Many of the findings only serve to confirm what is generally known concerning culvert structures. Others appear contradictory to what may be termed the general belief.

Effect of water acidity

Many West Virginia culverts carry drainage water that is partly or wholly derived from coal mines. The oxidizing effect of the air coming in contact with the minerals exposed in the workings causes such water to become highly impregnated with mineral salts, which generally give an acid reaction. Consequently, consideration was given to the determination of the pH values of all drainage waters, in an effort to correlate such values to the deteriorating effect of the water upon the culvert structures. The so called pH (hydrogen-ion) scale of values is a simple means of expressing the degree of acidity or alkalinity. As the Fahrenheit scale of temperatures expresses the heat conditions of water with the freezing point at 32 deg., so does the pH scale express the hydrogen-ion values with the neutrality point of pure water at 7. Values below 7 represent degrees of acidity; above 7 they show degrees of alkalinity.

It was found that water possessing a low pH value (high acidity) reduced the service life of practically all types of culverts, the metals being more sensitive than concrete to water acidity. Like all other materials, however, concrete showed a progressive, though slower, rate of deterioration as the pH value of the water decreased. Thus, where the water showed a pH value of 3 or less, the average annual deterioration of concrete was four times as great as when the pH was around 7.

A distinction is made between deterioration of culvert material and structural deterioration, although they both contribute to the ultimate failure of the culvert. The former appears to be a gradual process that continues more or less uniform throughout the life of the structure, due to the natural elements. The latter is caused by load stresses which generally reach a maximum within the first three years of fill adjustment, after which the effect is not pronounced. If, therefore, the culvert is properly designed and carefully constructed, its service life depends principally upon the ability of the material to withstand the elements. It is, therefore, not surprising to find that culverts possessing a continuous flow of water show a shorter service life than when the flow is intermittent.

Slope of culvert

The slope of the invert (that is, the gradient upon which the culvert is built) appears to be an unimportant factor in service life. No difference could be detected in the abrasive action of waste-laden water passing through culverts on steep gradients and culverts built with more gentle slopes. Also there appeared no greater tendency for jointed pipe to become separated, or to fail structurally on steep slopes than where the gradients are low.

In respect to filling, where detritus or silt was found deposited within the structure, it was observed that steep gradients are no panacea for this evil. While the percentage of the culverts showing filling grows less as the rate of gradient increases, the number of such culverts was considerable even when the gradient was more than 12 per cent, thus indicating the need for more careful consideration being given to the slope of the channel or ditch leading to and

FIG. 1—(LEFT) culvert survey equipment carried in board locker mounted on rear of automobile. (Right) hillside culvert showing dangerous scouring at downhill end.

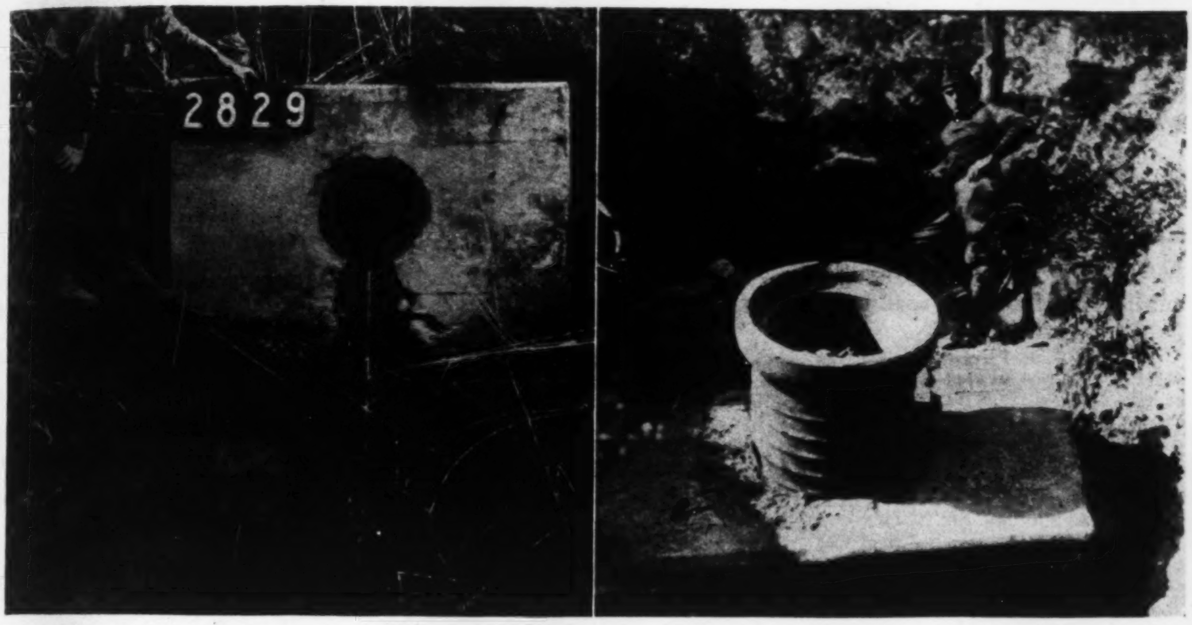


FIG. 2—(LEFT) concrete headwall showing deterioration by acid water. (Right) culvert pipe pulled apart by undermined head wall.

from the culverts. Where the gradient was less than 3 per cent, the corrugated pipe shows less tendency to become filled with silt than did the smooth-bore pipe. Above 3 per cent the reverse was found.

In the matter of structural strength to withstand earth pressures as measured by the depth of cover, more or less uniform results were observed in the case of cast iron, corrugated metal and reinforced-concrete pipe under all fills, ranging in depth from 1 to 24 ft. Vitrified clay pipe showed an increasing tendency to fail as the depth of cover increased beyond 2 ft. Reinforced-concrete box culverts showed increasing tendencies to fail when the depth of cover was more than 10 ft. Such structures, with a rectangular cross-section, appear to be ill-adapted to large depths of cover, and the indications are that better economy may be attained by designing circular cross-sections. Reinforced-concrete structures built in place indicated the need of transverse joints when the length was more than 50 ft.; otherwise they cracked transversely, due to temperature changes or unequal settlement, and in so doing the reinforced concrete was badly ruptured.

Contrary to the general opinion that trenching is necessary for pipe placed under fills, it was found in practice that the reinforced-concrete pipes that had been laid upon the surface of the original ground before the fills were constructed were in as good condition, structurally, as those which had been placed in excavated trenches before the superimposed fills were made.

Summer installations, generally speaking, showed slightly better ratings than work done during the winter months.

Paving of the invert in metal pipes appears to add greatly to the service life, provided it extends a sufficient distance up the side walls.

Head walls at the ends of pipe culverts appear to serve no useful purpose, considering the economy that is offered by an extension of the pipe to fit the slope requirements. They may possess an esthetic value, which is a matter of individual opinion, but they fail to add strength, to prevent joint separations or to increase the service life. More often they are a contributing cause of failure when carelessly constructed, being instrumental in pulling the joints apart. Culverts having no head walls averaged a better rating than those with head walls at one or both ends.

At the outfall end of culverts located on hillsides there is generally a pronounced scouring action, which deepens the outfall ditch and undermines the head wall, even when the foundations are fairly firm. It is suggested, where such condition exists, that in lieu of a headwall, a concrete apron be provided that will extend beneath the end of the pipe to provide support and, in addition, serve to break the fall of water and ease it into a natural channel.

In estimating the service life of different types of culverts it is important to consider the local conditions under which the structures function, such as the depth and character of fill, the stability of the soils, slips and earth movements, the character of the drainage water, as well as the engineering skill in location, design and workmanship. These factors vary widely between road projects and between geographical locations, so that the real value of a survey of this nature lies in the information which it offers to enable the engineer to meet the local condition.

Cleveland Slum Dwellers Stay Near Slum-Cleared Area

When living quarters in slum areas are demolished, where do their occupants move? An answer to this question is given by Howard Whipple Green following a study made of about 200 families moved out of the Cedar-Central Ave. area in Cleveland, which is being demolished in preparation for the erection of a low-cost housing project by the federal government. The study, made with the cooperation of the manager of the housing project and the Cuyahoga County Relief Administration, shows that most of the families moved to other near-by areas. Eighty-five per cent of the families moved less than 1 mile; 6 per cent from 1 to 2 miles; 4 per cent 2 to 3 miles; and 5 per cent more than 3 miles.

Most of the negro families, making up 57 per cent of all the families, relocated near by. About 94 per cent relocated within 1 mile, 4 per cent from 1 to 2 miles, and 2 per cent from 2 to 3 miles. On the other hand, 74 per cent of the white families relocated within a mile; 9 per cent moved from 1 to 2 miles; 6 per cent 2 to 3 miles; and 11 per cent moved more than 3 miles. The conclusion to be drawn, according to Mr. Green, is that families vacating a slum area to be rebuilt do not move to other areas, to create new slums. A similar conclusion was reached in a study of the Knickerbocker Village project in New York. Of 386 families living on the site, 86 per cent moved into adjoining blocks.

Paralleling Boston Post Road With a Superhighway

Connecticut begins work on 38 miles of the new four-lane road planned to parallel the famous Boston Post Road—A 300-ft. right-of-way is being taken to permit doubling the four-lane road being constructed at first

By E. F. Verplanck
Glenbrook, Conn.

GROWING TRAFFIC on the Boston Post Road northeast through Connecticut from the New York state line has long indicated the need of an alternate route. This year a 38-mile section of this relief road was finally located, and about a quarter of the mileage was placed under construction. In its structural elements this new road under construction ranks as one of the most modern of highway trunk-line developments in the nation. The 38 miles will cost about $15,000,000; the 8¾ miles actually under construction are being financed by NRA grants of 30 per cent and 70 per cent of Connecticut state highway department funds.

Development progress

Positive statement has to be confined at present to the 38 miles being considered for improvement in the immediate future; in fact, actual description of work cannot go much beyond the parts under contract (Fig 2). It is, however, contemplated as an eventuality that the alternate trunk line will be continued much farther, perhaps to the full length of the Boston Post Road in Connecticut. The present 38 miles extends from the New York state line near Greenwich, Conn., to Trumbull, Conn., about 4 miles north of Bridgeport. It has been named the Merritt Highway for Schuyler Merritt, congressman, from Fairfield County, in which the present mileage is located.

The movement for this highway has been going on for several years; indeed preliminary studies were begun in 1923. Negotiations for right-of-way began in 1931, and the first parcel of land was purchased on April 8 of that year. In October a project engineer residency was established at New Canaan, Conn., to conduct both the reconnaissance studies and the land purchases. The first contract for constructing 3½ miles at the Greenwich end was let in March, 1934, and a little later another was let for 3¼ miles at the Trumbull end. On Oct. 8 an additional 2 miles was under contract at the Greenwich end. The total mileage under construction is 8¾.

The point on the New York state line where the road begins is about 3½ miles northeast of the present northeastern end of the Hutchinson River Parkway of the Westchester County parkway system in New York. The county park commission has secured the right-of-way to extend Hutchinson Parkway across this 3½-mile gap, and funds for construction are expected to be available in 1935. The cost of grading, paving and six grade-separation bridges will be about $1,450,000. By this connection the Merritt Highway will be the principal motor route into New England from the New York metropolitan area.

Profile and structure

Line, profile and structure can be described specifically for only the mileage under construction, but the requirements here indicate fairly the general standards being set for the whole line. A 300-ft. right-of-way has been secured, and on this the 80-ft. subgrade is located offcenter so that its inside edge is 10 ft. off the center line of the right-of-way and its outside edge is 90 ft. off the center line. This eccentric location on the right-of-way leaves room for a similarly spaced parallel subgrade and road structure when traffic requires the additional travel width. Only half of the ultimate road, therefore, is now being built.

The parkway character of the road is observably emphasized. Besides the center grass plot there will be 4-ft. grass shoulders in fills and 2-ft. grass shoulders in cuts. The top edges of fills and cuts are rounded for 10 ft.; in rock cuts jagged protruding rocks are rounded off to simulate weathering, and dirt is placed where the rock will hold it, to encourage plant growth.

The more strictly structural features are shown by Fig. 3. The center grass plot, normally 21 ft. wide, narrows down at approaches to bridges where a 60-ft. pavement begins and is carried over the bridge. The dual pavements are 26 ft. wide (two 13-ft. traffic lanes) and are 2½ in. of bituminous macadam on a 6-in. stone base laid in two courses on a gravel sub-base in rock cuts and wherever else the ground conditions make it desirable. The subbase in rock cuts is 24 in. deep. The cut is made 2 ft. below the pavement base course and is backfilled with 18 in. of stone and a 6-in. cushion course of gravel. In rock fills no rock comes above a level 2 ft. below the bottom of the pavement base. Other structural features and dimensions are sufficiently indicated by Fig. 3.

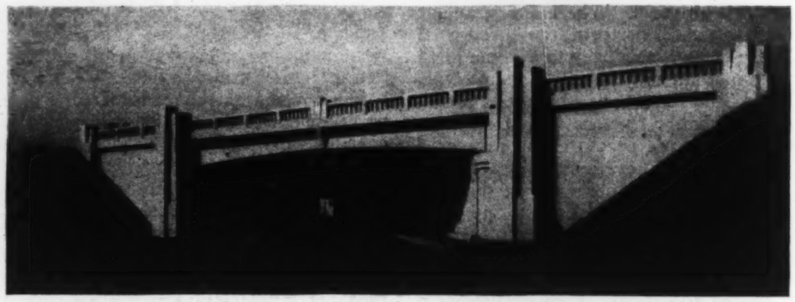


FIG. 1—OVERCROSSING at White Plains Road near Trumbull, Conn., characteristic of bridges on Merritt Highway.

Line and grade were both influenced by the location across the north and south ridges with streams between, which are characteristic of southern New England. For example there are five of these ridges in the first 12 miles at the west end. Careful location resulted in a reasonably easy line. On the 3½ miles at the Greenwich end 4,060 ft. per mile are on tangent and 1,220 ft. are on curve; on the 3¼ miles at the Trumbull end the ratio is almost the same. Of the six curves in 3½ miles at the Greenwich end one is 7 deg., 590 ft. long, one is 6 deg., 800 ft. long, and the others are 2 and 3 deg. On the 3¼ miles at the Trumbull end there are five curves, the sharpest being 6½ deg. and the others 4.3 and 1 deg.

In the first 3½ miles practically half of the road is on grades and half on vertical curves laid off by a parabolic formula to produce a rate of change of 1 to 2 per cent in the grade per 100 ft. Most of the grades are under 4 per cent. There is, however, one stretch 150 ft. long on a 4.7 pr cent grade, one 250 ft. long on 5.55 per cent grade and one 50 ft. long on 6 per cent grade. These

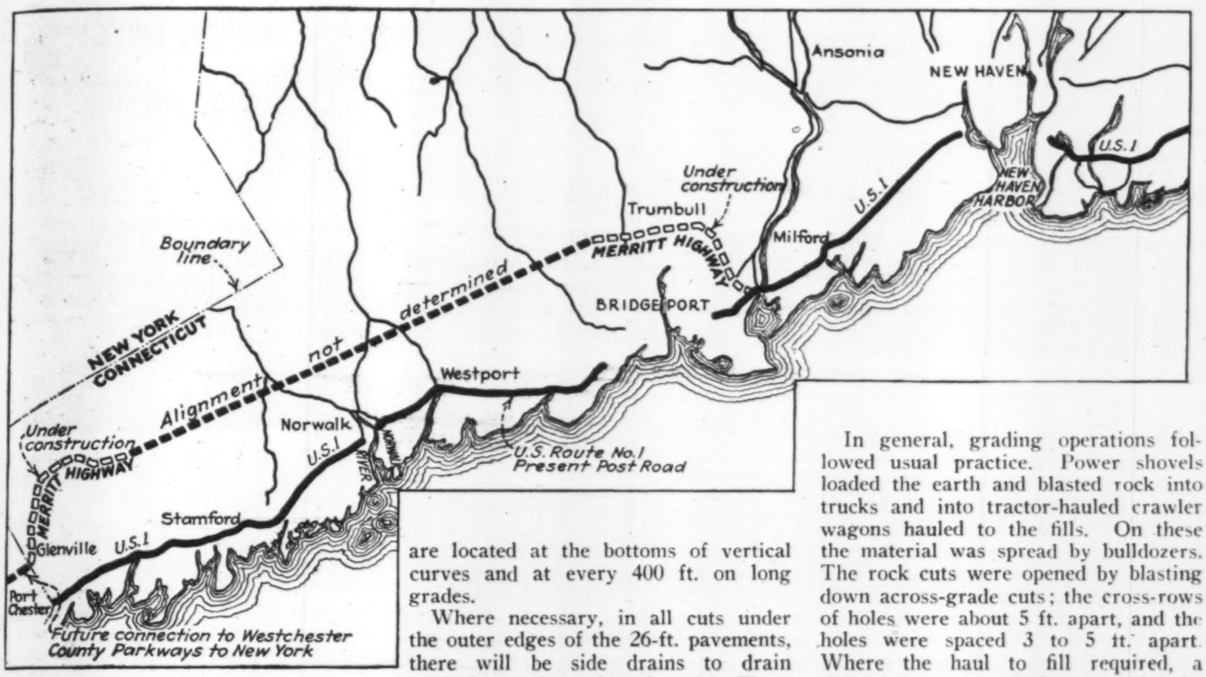

Ansonia
NEW HAVEN
U.S.1
NEW HAVEN HARBOR
Under construction
Trumbull
MERRITT HIGHWAY
Milford
U.S.1
Boundary line
BRIDGEPORT
NEW YORK
CONNECTICUT
Alignment not determined
Westport
Under construction
MERRITT HIGHWAY
Norwalk
NORWALK RIVER
U.S.1
U.S. Route No. 1
Present Post Road
Stamford
Glenville
U.S.1
Port Chester
Future connection to Westchester County Parkways to New York

FIG. 2—BOSTON POST ROAD, showing located portions of Merritt Highway.

short steeper stretches on long grades are located where the road emerges from heavy cuts onto heavy fills and were introduced to reduce earthwork. At the Trumbull end the ridges are less pronounced, and the grades are somewhat more moderate.

A noticeable feature of the line design is the reduction of access roads. On the first 5½ miles at the New York end there will be access only from three slightly traveled roads, which will be brought in at grade, with crossing permitted around an island 150 ft. long. On the 3¼-mile section at the Trumbull end one unimportant street serving a few houses will cross at grade. Essentially the road is planned for serving fast through traffic with the least interruption practicable.

The drainage of the new road will be unusually complete. There will be 47 catchbasins and 15 manholes on the first 3½ miles at the Greenwich end, 54 catchbasins and 19 manholes on the 3¼ miles at the Trumbull end. A manhole is provided at every Y or T connection in the 12-in. concrete run-off pipe from the catchbasins; all will be located in the central grass plot. The catchbasins are located at the bottoms of vertical curves and at every 400 ft. on long grades.

Where necessary, in all cuts under the outer edges of the 26-ft. pavements, there will be side drains to drain groundwater from the subgrade. These drains will be 4 ft. deep and of 6-in. corrugated metal pipe with the top half of the circumference perforated with ¼-in. holes spaced about 2 in. apart. The trenches are back-filled to within 12 in. of the top with 3-in. stone, and above with gravel. To drain the subgrade of groundwater at the downhill ends of rock cuts, the excavation is sloped down from the center toward the sides. This is designed to prevent any damming up of water at the beginning of the fill. Drainage across the road is by reinforced-concrete pipe from 15 to 48 in. in diameter.

Grading methods

The grading operations on the three contracts awarded call for the moving of about 1,100,000 cu.yd. of earth and rock, or about 122,000 cu.yd. a mile. The division of the work is given in the accompanying table. The heavy rock excavation of about 63,000 cu.yd. a mile places this contract well up among the large rock-grading operations for roadwork in New England.

In general, grading operations followed usual practice. Power shovels loaded the earth and blasted rock into trucks and into tractor-hauled crawler wagons hauled to the fills. On these the material was spread by bulldozers. The rock cuts were opened by blasting down across-grade cuts; the cross-rows of holes were about 5 ft. apart, and the holes were spaced 3 to 5 ft. apart. Where the haul to fill required, a through cut was made first, and then the cut was widened. Commonly several cross-cuts were blasted at a time, some of the blasts embracing 150 holes and consuming 2,000 lb. of explosive. The rock broke generally into suitable sizes for shovel loading.

It was required that fills should be placed in 3-ft. layers, and in order to increase the room for trucks and dumping, several layers were constructed simultaneously, each upper layer being stepped back 100 ft. from the one below it. On side-hill fills 12-ft.-wide steps or shelves were cut in the hillside to stabilize the fill against sliding. This and other typical grading operations are indicated by the views, Figs. 4 to 6.

Bridges and culverts

Bridges on the Merritt Road are chiefly notable for their simple handsome form, their substantial structural design, and their roadway width of 60

CONTRACT QUANTITIES IN PARTS OF MERRITT HIGHWAY

Item	Sect. 1 (Greenwich) Cu.Yd.	Sect. 2 Cu.Yd.	Sect. 1 (Trumbull) Cu.Yd.
Rock excav.	220,000	79,000	80,000
Earth excav.	110,000	133,000	260,000
Top-soil excav.	30,000	6,600	12,000
Fill	412,000	212,000	396,000
Borrow	82,000	....	56,000

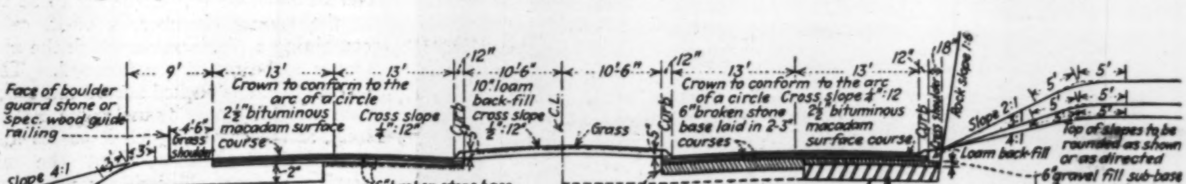

9'
13'
13'
12"
10'6"
10'6"
12"
13'
13'
12"
18"
5'
5'
5'
5'
5'
Face of boulder guard stone or Spec. wood guide railing
4'6" Grass shoulder
3'
3'
2'
2"
Slope 4:1
Slope 1½:1
Crown to conform to the arc of a circle
2½" bituminous macadam surface course
Cross slope ¼":12"
Curb
10" loam back-fill cross slope ½":12"
C.L.
Grass
5"
Curb
Crown to conform to the arc of a circle Cross slope ¼":12
6" broken stone base laid in 2-3" courses
2½" bituminous macadam surface course
Curb
Grass shoulder
Rock slope 1:6
Slope 2:1
3:1
4:1
Loam back-fill
Top of slopes to be rounded as shown or as directed
6" gravel fill sub-base where required
Section in rock cuts
Generally 50'
Center line of right-of-way
No rock used for embankment shall be placed above this line
6" broken stone base laid in 2-3" courses
12" gravel fill sub-base where required
Rock to be excavated to this line
18" stone fill sub-base where required

FIG. 3—HALF-WIDTH SECTION of Merritt Highway being constructed on one side of 300-ft. right-of-way paralleling Boston Post Road in Connecticut.

ft. None of them are of large span or unusual type. The bridge shown by Fig. 1, a 60-ft. span over a state highway at the Trumbull end, is typical of the attractiveness of design that has been sought.

The largest bridge structure so far under construction is at mile 1¾ at the western end. It will carry the highway in two twin spans over the Riversville Road and the east branch of the Byram River. It will be skewed at an angle of 53 deg. It is of reinforced concrete and encased steel-girder design, spans 48 ft. in the clear, road clearance 14¾ ft., width of deck for highway 60 ft. The foundations are on bedrock, which is near the surface at this point.

There are thirteen girders in each span, spaced 5 ft. c. to c. The eleven central girders on each span are 36 in., 230-lb girder beams. The outer girder is a 36-in., 260-lb girder beam. These girders are 64 ft. long and weigh 9 tons. They were shipped with 1½-in. camber. The computed deflections for the dead load are 1.09 in. for the inner beams and 1.13 in. for the outer. The bridge is designed for H-20 loading.

The bridge is of the same general appearance as the newer highway bridges to be seen throughout Connecticut. The railings are of square concrete pillars, and the structure is surmounted by pylons. The appearance is further improved by use of sunken paneling on the abutment faces. The central pier has seven columns topped by arches. The forms were constructed of 1¼-in. stock and lined throughout with plywood. The finished exposed surfaces were rubbed with carborundum. A 750-watt vibrator was used during pouring.

FIG. 6—SHELF CUTS made to stabilize steep side-hill fills.

FIG. 4—ROCK CUT on Merritt Highway, showing widening of preliminary through-cut made for trucks hauling to fills.

FIG. 5—ROCK FILL being made in 3-ft. layers stepped back to give truck room for depositing two or more layers simultaneously.

The design and construction of the Merritt Highway is being carried out by engineers of the Connecticut highway department, John A. Macdonald, commissioner. The contractors for various parts of the work are: Peter Mitchell, Inc., Greenwich, Conn.; Lee Construction Co., Boston, Mass.; John Arborio, Poughkeepsie, N. Y.; D. V. Frione Co., New Haven, Conn.; and the Mariani Construction Co., New Haven, Conn.

◆

Full-Scale Wind Tunnel Completed in France

The full-scale wind tunned which the French Air Ministry has had under construction for the past two years has now been completed and will soon be placed in use.

The new tunnel, utilizing American experience gained in the construction of the Langley Field wind tunnel, has been built at Chalais-Meudon, and will allow tests to be made of aircraft with wing spans up to 50 ft. An air flow up to a speed of 160 ft. per second, or about 110 m.p.h., may be attained.

The tunnel consists of two elliptical pipes with the testing chamber set between them. The air is sucked through from the first to the second by means of air screws set at the extremity of a suction chamber. The mouth of the collector tunnel has a maximum diameter of about 85 ft., narrowing to 52 ft. at the testing chamber, a 65-ft. cube containing a platform on which the airplanes to be tested are fastened. The stream of air is sucked across this space into a much longer tunnel some 300 ft. long, at the end of which it passes into the suction chamber, past the air screws, and out through six ventilator holes. The testing chamber opens into a big central hall in which aircraft may be assembled or prepared for tests.

Continuous Concrete Girders Use Steel Hanger Joints

Highway bridge near Seattle has a continuous length of 260 ft. between joints placed at points of contraflexure in 90-ft. girders—Suspended load at joints carried by short steel eyebars and pins

By Thomas D. Hunt
Formerly County Engineer, King County, Wash.

THE Marine View Highway is a scenic drive under construction along the eastern shore of Puget Sound from the Canadian boundary to the head of the sound at Olympia; a route which affords a commanding view across the Sound to the rugged mountains of the Olympic peninsula. Midway between Seattle and Tacoma, where the highway is under improvement by King and Pierce counties, the road crosses a ravine in Salt Water State Park, where the grade is about 100 ft. above the level of the streambed. Here a bridge of considerable size and importance was required, and much thought was given to developing a design of pleasing appearance in keeping with the sylvan setting. The bridge selected, and recently built, is a 570-ft. concrete structure of continuous type, with six girder spans from 80 to 100 ft. in length. The outstanding feature, described in detail in the following, is the suspension joint used at one-third points in each of the 90-ft. spans. These joints, which are points of contraflexure for dead load, determined the 260-ft. length of the unjointed central portion of the bridge.

Span and roadway layout

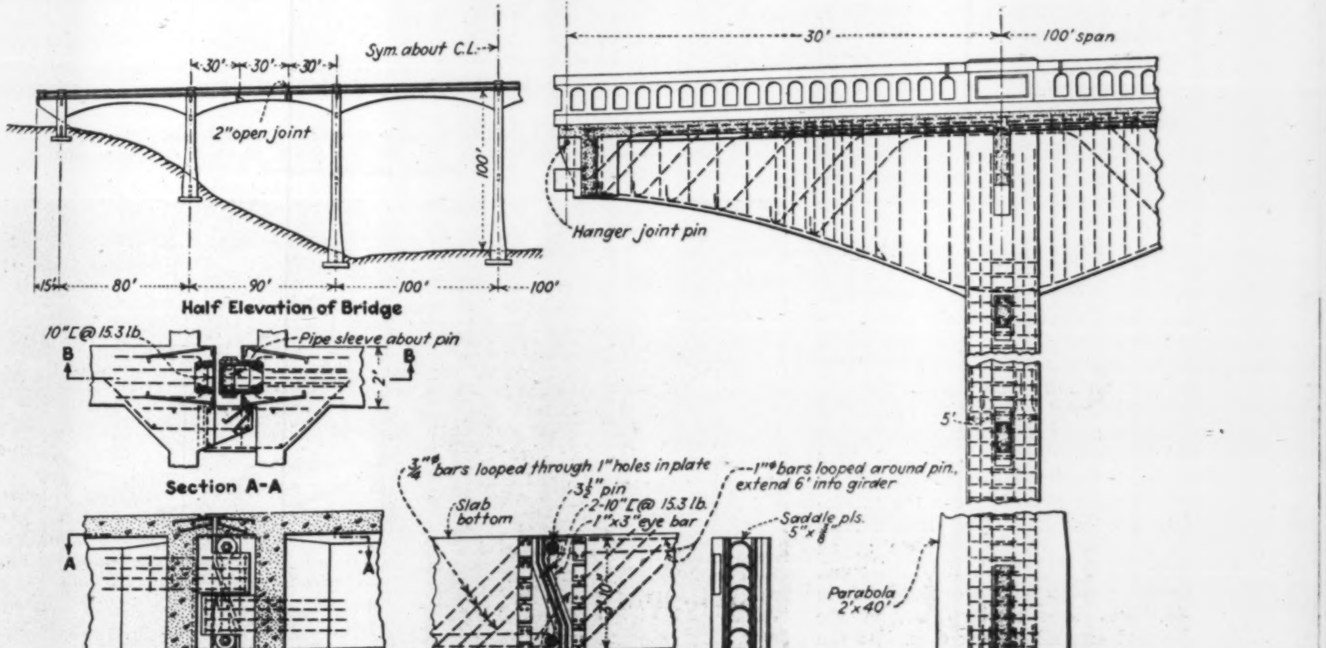
The bridge is symmetrical about the center pier, on either side of which the successive spans are 100, 90 and 80 ft., respectively, with a 15-ft. cantilever end. The roadway is 24 ft. wide, has 9-in. curbs and on one side a 4-ft. sidewalk. In order to equalize deck dead loads on the girders, therefore, the center line of the roadway was offset 1 ft. 10 in. from the center line of the bents. The two girders, 24 in. wide and of variable depth, are spaced 16 ft. apart c. to c. Between them is the concrete floor slab, 9 in. thick at the center, deepening to 14 in. at the girders. At the bents and at the third-points of the 90-ft. spans are cantilever brackets, whose function is largely architectural, projecting from the interior transverse diaphragms that connect the girders.

The bents consist of two rectangular columns on 1:24 batter, and are braced by ties and diaphragms. The columns have a 2½x5-ft. horizontal section at the top, the 5-ft. dimension parallel to the bridge center line, and for appearance are shaped to parabolic curves on their sides, which increases the column width to 9 ft. at the bottom of the tallest bent.

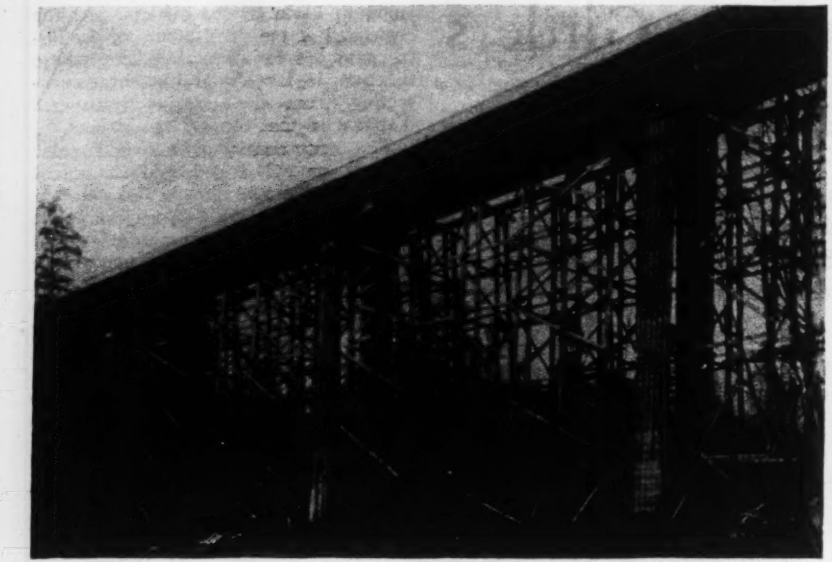
The design was based on a method of joint translation developed by Prof. A. L. Miller, of the University of Washington, for use in continuous girders. Results were checked with a celluloid model by the Beggs deformeter method and showed very close agreement. With the girder depths required at the points of support, it was found that the points of contraflexure for dead load would occur, in an unjointed structure, at the one-third points of the 90-ft. spans. By placing joints at these points not only was a desirable distribution of dead-load stresses obtained, but, since live loads constitute only a small portion of the total loading, the result was a better balance and more economical stress distribution than would have resulted from the more conventional arrangement of joints in which they are placed directly over the bents.

Steel hangers at joints

Each deck joint consists essentially of a pair of eyebar hangers. With the


Sym. about C.L.
30'
30'
30'
2" open joint
100'
15'
80'
90'
100'
100'
Half Elevation of Bridge
30'
100' span
Hanger joint pin
5'
10"[@ 15.3 lb.
Pipe sleeve about pin
B
B
2'
Section A-A
A
A
Asbestos packing
2"
Longitudinal Section Through Joint
¾"ϕ bars looped through 1" holes in plate
Slab bottom
3½" pin
2-10"[@ 15.3 lb.
1"x3" eye bar
1"ϕ bars looped around pin, extend 6' into girder
1 pl. 17⅛"x1"x3'-10"
2" open joint
Section B-B
Saddle pls. 5"x⅜"
7"
10"
7"
2'
Elevation
Parabola 2'x40'
9'
16'

STRUCTURAL DETAILS of continuous-girder concrete bridge in which steel hanger joints are used at points of dead-load contraflexure 260 ft. apart.



CONTINUOUS-GIRDER concrete highway bridge before removal of falsework. The two spans shown are each 100 ft. long, and the roadway at this point is about 100 ft. above ground level.

adopted position and type of joint, the reactions are only one-third to one-half as great as those of joints over supports, friction is at a minimum, the joint remains clean, and the hanger tends to return to its normal vertical position. It was recognized that a joint of this type must have special care in construction.

Essentially the joint consists of steel encasements for the companion girder ends, the eyebars and their pins. Each girder-end encasement includes two vertical steel plates 1 in. thick, cut with an offset along one side and held 10 in. apart along the offsetting sides by a correspondingly shaped 10-in. steel channel which closes the space between them. A 2½-in. pin bearing on the pair of 1-in. steel plates and carrying 1x3-in. eyebars, passes through a 10-in. pipe sleeve between the two plates. Angles and strap anchors welded together complete the assembly.

From the main plates the load is passed on to the concrete by a set of five saddle plates bent in a semicircle and equally spaced vertically above one another along the straight rear edges of the main plates. This set of saddle plates is centrally embedded in the concrete girder. Additional connection with and anchorage to the concrete is had through four ¾-in. hairpin bars passing through 1-in. round-edged holes in each main plate between the saddle-plate attachments. The hairpin bars are embedded in the concrete at an angle of 45 deg. with the horizontal. Another connection is provided by three 1-in. bars bent to loop around the pins and extending back 6 ft. into the girder. Finally, there is also the bond over the inner surfaces of the entire encasement, bearing on rivet heads, etc. In making the design, care was taken to provide space for tamping on both sides of the saddle plates, to make sure that full bearing beneath them would be obtained.

On either side of the girder ends at the joint, connecting and confining them, are transverse concrete diaphragms 12 in. wide with cantilever ends. Immediately adjoining the eyebar hangers on the inner side of the girder, brackets project forward from the diaphragms. The brackets on the suspended side directly overlaying the brackets on the supporting side with a vertical separation of ¾ in., which space is filled with a layer of asbestos packing between ½-in. steel plates. These brackets transfer wind and other lateral forces across the joints by contact at their sides with the steel encasement of the girder ends. By their superposition they are a potential safeguard against harm in case anything should go seriously wrong with the eyebar hangers.

Concrete quality and costs

For the deck concrete, specifications called for 1.81 bbl. of cement per cu.yd., with 3 in. as the maximum aggregate size. The specifications required this concrete to have a 28-day strength of 3,000 lb. per sq.in. and a working stress of 1,000 lb. per sq.in. in flexure. In columns and substructure, specifications called for 1.41 bbl. of cement per cu.yd. of concrete. Test cylinders taken during the work showed strength varying from 4,520 to 6,857 lb. per sq.in. in 28 days. Reinforcement was intermediate grade, deformed and stressed at 18,000 lb. per sq.in.

Bids on the job (eight) ranged from $65,990 to $50,715; the latter was the bid submitted by Nelse Mortensen & Co., to whom the contract was awarded and to whom credit should go for the excellence of the work. As the bridge is 570 ft. long, the foregoing figures make the cost $88.97 per lin. ft.

Falsework was framed with long piles to the top of the columns, at which level they were cut off and capped. The remainder of the falsework was of sawn lumber. A cableway located over the center line of the bridge handled all material. Considerable delay at the outset arose from foundation conditions. Bents 3, 4 and 5 were put on pile foundations, the remainder are supported on concrete footings poured in the soil.

The bridge was designed in the office of the King County engineer and constructed under his supervision when the

STEEL JOINTS FOR GIRDERS at points of dead-load contraflexure. The saddle plates transfer the load from the 1-in. steel side plates, to which the hanger pins connect, into the concrete.

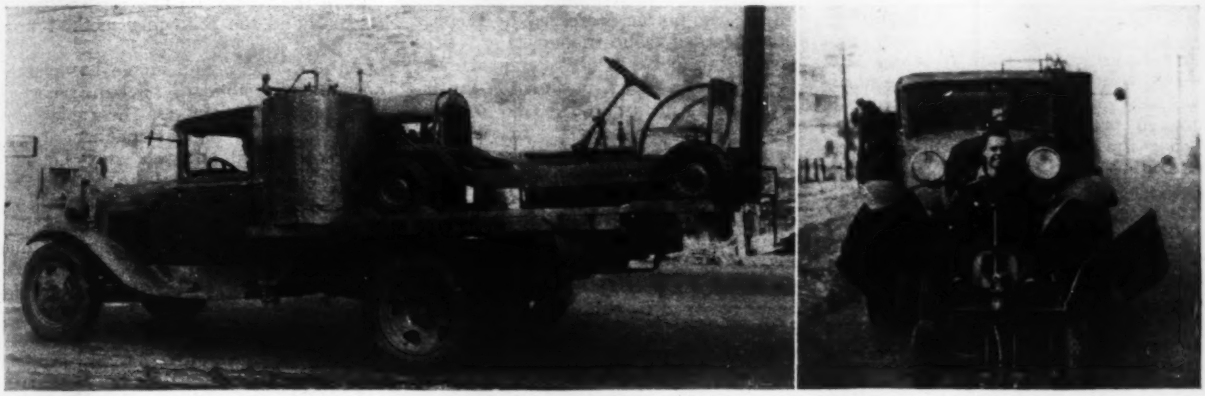
writer held that position. H. W. Birkeland, of the county engineer's staff, made the stress analysis using Professor Miller's method. The suspension-type joint in its complete arrangement of parts was suggested several years ago in connection with another bridge (on which the joint was not used) by H. M. Hadley, structural engineer of the Portland Cement Association. The joint was easy to install and appears to be entirely satisfactory.

Painting Traffic Stripes on Utah Roads

New machine, capable of painting 15 miles of stripes per day, pushed by a truck that carries the compressor and paint tank

By Gail Martin
Salt Lake City, Utah

A MACHINE to paint traffic lines on highways has been developed by the Utah state road commission under the direction of K. C. Wright, chief engineer, and Ed. Allen, master mechanic, Salt Lake City. The machine, a variation of the device used by the Oregon road commission, has, after a few months' service, demonstrated its practicability under the most trying conditions. At an estimated cost not to exceed twenty-five dollars a mile for labor and materials as well as upkeep and depreciation, the machine will paint on an average of 15 miles a day.



TRAFFIC-STRIPE painting outfit showing (left) service and power-plant truck and (right) the machine being pushed ahead of the truck.

The full equipment consists of a 1½-ton truck that carries the compressor and paint tank and at the same time pushes the striping machine. On the right-hand side of the truck a two-stage, 10-hp. air-cooled compressor, with a capacity of 42 cu. ft. per minute at sea level, supplies the motive power for the paint gun carried on the striping machine ahead. Beside the compressor is a 6-ft.x18-in. air receiver capable of withstanding 150-lb. pressure. Air pressure is held at 100 lb. A regulator reduces this to 75-lb. pressure in the line extending to the paint gun, while another regulator reduces the pressure in the air line running to the 100-gal. paint tank on the left side of the truck to a pressure ranging from 5 to 15 lb. At the rear and left end of the truck is a rack on which the striping machine can be loaded when being transported. At the front of the truck a 4-ft. steel bumper with a 2-in. slot is provided for attaching the rear end of the striping machine to the truck. This coupling device consists of a 1½-in. steel pin that buckles into the slot; a sliding sleeve keeps the coupling pin from being unfastened but leaves it loose enough to slide to and fro in the slot.

The striping machine consists of a car made of angle iron and mounted on 4x16-in. pneumatic tires. At the rear end is the seat of the operator, who steers the machine to the line laid on the pavement. At the front end is a blower, which removes the dust from the pavement. Back of this are two 14x½-in. steel disks that can be set at distances varying from 2 to 6 in. apart, according to the width of line desired. The supporting arm of the disk moves up and down so that the disks can ride over obstructions or slight inclines in the pavement. Between the disks a spreading gun has been set so that the stream of paint will strike the pavement vertically midway between the disks. Both the disks and the paint gun are made to turn with the front wheels on curves. A ⅛-in. line conveys the fluid paint from the paint tank to the gun. Traffic-line lacquer is used because it will dry in 30 min., the maximum time that can be allowed.

The driver of the truck pushing the striping machine does not need to drive true to the line since the driver of the striping machine steers his car independently of the truck. By keeping the pointer at the front of the striping machine on the line, a remarkably straight stripe can be made. Once the stripe has been laid or can be faintly seen, a new one can be painted without laying guiding strings. Any length of guiding string can be used on straight stretches, although the length is generally about 500 ft. The designers of the machine are now working on a device to eliminate the need of putting down a guiding string; by putting sights on the striping machine it is believed that stakes can be set up at a distance and the operator can steer the car straight to the point.

Stripe painting costs

A comparison by Mr. Wright of the cost of striping by machine and by hand gives the following facts:

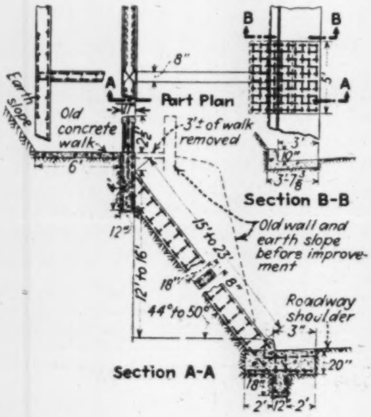
The machine uses 10 gal. of paint to the mile at $1.95 a gallon, which gives a cost of $19 for paint alone. On old work, the average speed of retracing lines is 10 miles daily with but two men employed; the maximum is 15 miles. On new work the expense is greatly increased because then a crew of twelve men must be employed. Two men only are used on the machine, but ten more attend to other details. On new work not more than 5 miles a day is the average. If the work were to be done by hand, as formerly, it would cost double the machine cost, or $50 a mile when the traffic stripe is painted only every alternate 200 ft., as is sometimes done. For a continuous stripe, hand work would cost at least four times as much, or about $100 a mile.

From Job and Office

Novel Concrete Wall Protects Ocean Boulevard Slope

PARAPET WALL and the ribs that support it along Ocean boulevard near Santa Monica, Calif.

THE California state highway that extends along the ocean shore north of Santa Monica at one point passes through private property where excavating the desired width of roadway necessitated cutting into a private concrete walk built along a steep side hill. Protection of the existing improvement was accomplished without unsightly disfigurement by a concrete parapet wall along the outer edge of the sidewalk. This parapet, in turn, was made stable on the steep slope by long concrete struts embedded in the slope and extending from the parapet to heavy concrete footings set below the level of the highway cut at the bottom of the slope. These struts were spaced 20 ft. apart, center to center, and the slope between them was set out in ice plant. At the base of the slope along the curb a cypress hedge was planted. By narrowing the existing walk only 3 ft. (for which permission of the owner was secured) the actual highway width was increased by 10 ft. The general appearance of the improvement nearing completion is shown in the accompanying picture; details are given in the drawing.



PLAN AND SECTION, showing details of the concrete parapet and its supports

Cushions Made of Truck Tires for Concrete-Bucket Cars

THE 8-CU.YD. concrete buckets used in the construction of Boulder Dam are moved from the mixing plant to the several cableways on standard-gage flat cars divided into compartments by partitions. These partitions are about 2 ft. high and are built up on three sides as an aid to getting each bucket into its assigned position. Smoothness of the operation has been improved and wear on the equipment decreased by the use of discarded solid-rubber truck tires fastened to the walls of the compartment to serve as cushions, as shown in the accompanying picture.

It is only empty buckets that are delivered to these compartments, and hence a lighter structure can be used than would be necessary if loaded buckets were swung in from the overhead cableway. The empty bucket placed on the car by the overhead cableway is conveyed to the mixer, there receives its load without being removed from the car, and the car is returned to position beneath the cableway. Removing the loaded buckets by cableway is an operation capable of relatively smooth movement, and there is no risk of rough handling.

Returning the empty buckets to the car is somewhat different in that, for an overhead cableway, relatively accurate placement is necessary in a minimum of time. Hence, the buckets not infrequently bump the sides or the ends of the compartments. Here the old rubber tires function to good advantage and cushion the shock, with resultant saving of time and wear.

FLAT CAR at Boulder Dam with compartments for concrete buckets cushioned with old rubber tires.

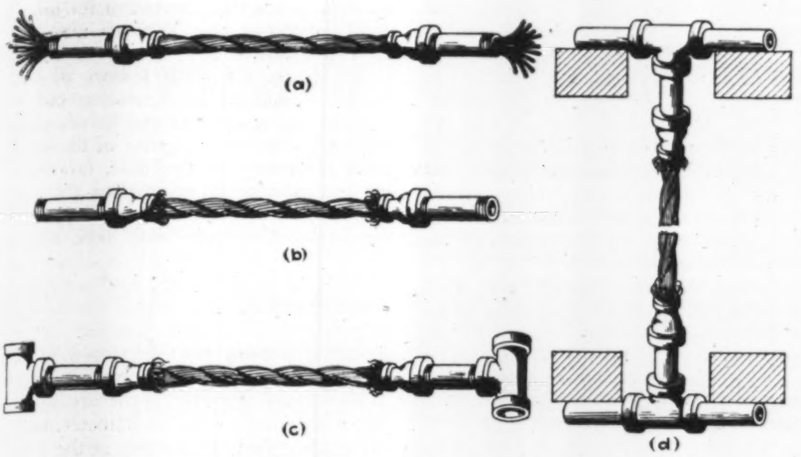
Socketing Guard-Cable Test Specimens

By D. V. Pickle
Technical Assistant, Texas Highway Laboratory, Austin, Tex.

THE TEXAS highway department specifications for guard-cable call for a total tensile strength of 13,000 lb. for ¾-in., three-strand cable. When the highway testing laboratory first started making tests, some trouble was experienced in getting a proper socket. The first socket used consisted of a short length of pipe pressed in on one end and held in the serrated grips of the testing machine. A large number of pull-outs of the zinc made this form unsatisfactory, and the following method was devised.

A 6-in.-long, 1¾-in. nipple has placed on one end a standard 1¾x1-in. reducer, this making the socket. The cables are prepared in the regular manner, and a socket is placed on each end. Oakum is tightly packed around the cable at the small (inside) end of each reducer, and the molten zinc is poured around the bushed wires. The zinc cools and solidifies before the oakum is burned. After cooling, a standard 1¾-in. tee is placed on each socket, and a steel shaft of 1⅝-in. diameter is run through each tee as the cable is placed in the machine.

Standard wrought-iron fittings are utilized throughout. This method has been in use for three years without the



SOCKETING GUARD-RAIL CABLE for tensile tests: (a) cable with the sockets on and the end bushed; (b) sockets pulled down over the bushed wires and the reduced ends tightly packed with oakum; (c) poured sockets after cooling and being fitted with tees; (d) finished specimen with shafts inserted into the tees and the specimen placed in the testing machine.

loss of a specimen during test, with loads as high at 20,000 lb. The nipples and reducers are kept assembled, and recovery of the zinc is readily made by placing them on an inclined bracket over a fire-pot or blow torch. By increasing the size of the fittings, it is believed that this method would be applicable to the larger-size cables.

This method of socketing guard-cables was worked out by the writer under the direction of W. H. Wood, engineer of materials and tests, Texas highway department.

Timber Made Fire-Resistant by Magnesium Chloride Spray

Timber supports in tunnels of the Metropolitan Water District of Southern California are made fire-resistant by treatment with magnesium chloride sprayed on with portable equipment, which requires only connection to a compressed-air line to be ready for operation. Total cost for material and labor has been about 10 c. per linear-foot of tunnel, and although the treatment is in nowise complete fireproofing, in dry tunnels the protection it affords is believed to be well worth the cost.

The chemical is purchased in the form of a saturated solution at a cost, delivered to the camps in 10,000-gal. lots, of about 3 c. per gallon. About 1½ gal. per linear-foot of tunnel is the usual application, and the equipment for putting it on consists essentially of a 25- or 30-gal. tank delivering through a hose with a spray nozzle. The tank is mounted on a flat car, and a hose line is provided for connection with the tunnel compressed-air pipe. A crew of two men ordinarily applies the treatment, and their average rae of progress is about 200 ft. of timbered tunnel per eight hours. Where the average spacing of timber sets is about 5 ft., the quantity of material used is about 1½ gal. of the chemical per linear-foot of tunnel.

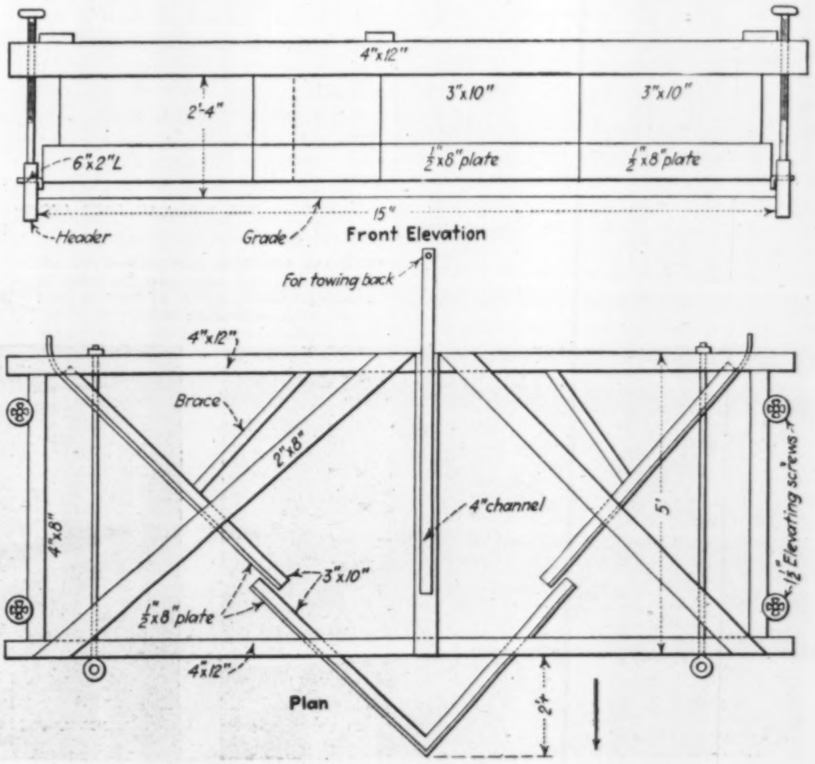
Before adopting this method of timber treatment for the aqueduct tunnels, a timber falsework resembling a section of tunnel lining was built outdoors and was given the same treatment used on the tunnel timbers. When 24 hours had elapsed after the treatment, the test timbers were subjected to a very hot fire without being even charred. However, a year later, during which the test timber sets remained exposed to the weather, fire again was built in the same structure. This time the timbers caught fire and were destroyed, indicating that in the open air, at least, the fire-resistant quality resulting from the chemical treatment does not last indefinitely.

Home-Made Drag Spreader for Narrow Asphalt Pavement

A drag for spreading asphaltic concrete has greatly facilitated placement of this material on southern California pavement strips less than 20 ft. wide. The greatest advantage appears in paving laid in widths exceeding the width of one spreader box, but not wide enough to use two. The device is a V-shaped spreader made up of steel-faced 3x10-in. timbers supported by a timber frame which slides along the header boards on angle irons and is adjustable by means of elevating screws to accommodate any desired pavement thickness.

The opening in the spreader box is set to allow the necessary quantity of material to be deposited on the prepared grade; and the drag, towed behind the spreader box, spreads the material uniformly between headers and leaves it ready for the finishing machine. Under conditions ordinarily obtaining in southern California a 2-ft. 4-in. height of the framework supporting the spreader is about a minimum necessary to clear

PLAN and ELEVATION of a home-made asphaltic-concrete spreader, which effects a uniform distribution of the material left in the center of the roadbed by the spreader box.



the loose material that will pile up in front of the spreader and tend to stall the machine. Steel plates, not shown in the drawing, parallel to the headerboards, prevent loose material from flowing out over the headers.

The device was developed by Tom Polich, of the United Concrete Pipe Co., and has been used in District VII of the California division of highways.

Ground for Sewer Excavation Thawed by Oil Fire

By George F. Brousseau
Engineer, Sewer Commission, Braintree, Mass.

BRAINTREE, MASS., is putting in about 4 miles of sanitary sewers as a PWA project by force account. Because the ground is frozen to a depth of 18 to 36 in., it is necessary to take out the top of the trench by jackhammer, or by first thawing the earth so that it can be removed by pick and shovel. They have found the jackhammer method too slow and costly, and resort has been had to heating.

Most of the work is in streets having a light tar-macadam surface, and this surface is broken out with jackhammers. Pine mill slabs are then placed in the trench, sprinkled with kerosene oil, then heavy fuel oil is applied with shovels and covered with half-sections of old steel chimneys, 36 in. in diameter and about ⅛ in. thick, and from 12 to 15 ft. long. The fire is then started and the heavy fuel oil is added by shovels at the open ends, as required. This heavy oil thins under the heat and flows, spreading under the covered surface, creating an intense heat which is deflected downward because of the cover. These fires are started at about 2 a.m. and tended till about 6 a.m., when they are allowed to die down so that the covers can be removed, to start the excavation work at 8 a.m.

It has been found that such heating thaws the ground to a depth of 18 to 20 in. in clay and hardpan and 24 to 30 in. in gravel.

Unit costs observed are as follows:

Pine slabs delivered on the street......	$9 per cord
Kerosene oil delivered on the street	$ .085 per gallon
Heavy fuel oil, No. 6, at the plant	$ .0375 per gallon
Labor	$ .50 per hour
Trucks, 1½-ton, without drivers	$ .85 per hour

DETAILED COSTS OF 900 FT. OF TRENCH, 3 FT. WIDE

243 man-hours @ $.50	$121.50
81 truck-hours @ $.85	68.85
6½ cords of slabs @ $9...........	58.50
109 gal. kerosene @ $.85	9.27
1,580 gal. heavy fuel oil @ $.0375..	59.25
900 ft. of trench @ $.353 per ft. ...	$317.37

◆

Novel Tools Notch Timbers to Make Bond with Concrete

DESIGN of the Railroad Ave. seawall in Seattle requires the transfer of tension from a horizontal concrete slab into 12x14-in. timber caps supported on piles. To effect a bond between the concrete and the timber, recesses or slots are left in the horizontal member of the concrete slab, and the shape of the forms in which the slabs are cast is such that the inner faces of the concrete in the slots have notches to correspond roughly with notches cut in the heads of the caps. The slots are somewhat larger than the timbers so that, on assembly, the space between can be filled with concrete and thus there are provided square-cornered shoulders for the transfer of stress.

To saw the timber notches by hand would have been slow and expensive, so special equipment was designed and built in Seattle, using motor-driven cutter heads for performing this work. These cutters not only make the notches in the timbers speedily and accurately but also cut the grooves required as keyways. The keyways are made of such cross-sectional shape that, instead of the usual short lengths of pipe, keys are made of cement mortar.

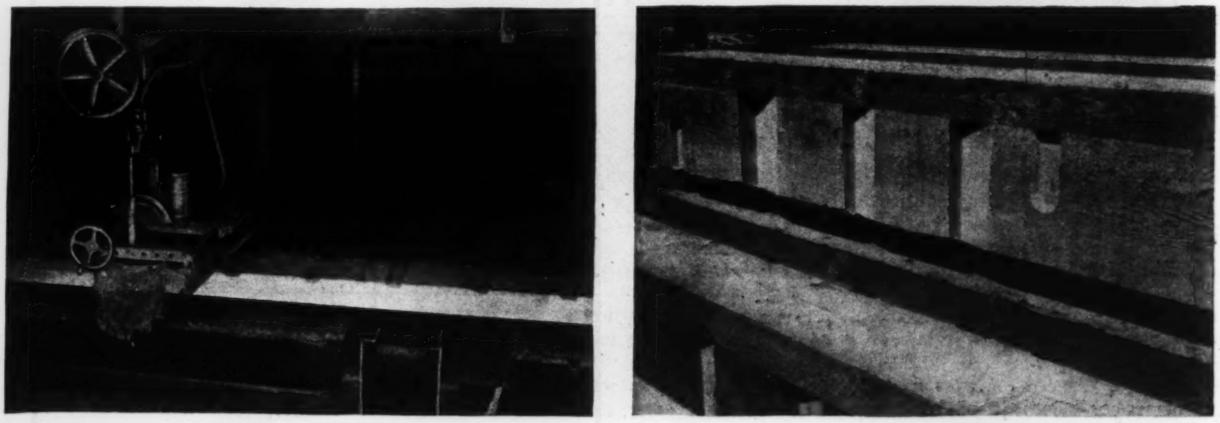
The essentially novel feature of the special equipment is a rotating cutter head in which are fastened knives projecting beyond the periphery of the head as in a planer. In this case, however, the cutting head is mounted on the end of the driving shaft, and by mounting the motor in a frame with hand wheel control it has practically universal motion so the head can be swung into any position and locked. For this, it was necessary to provide a thrust bearing; hence a special housing was developed for a standard 5-hp., 3,500-r.p.m. motor.

Two types of cutter heads are used: one is a cylinder 6 in. in diameter, used for making the large notches at the ends of the timbers; the other head is of smaller diameter, and the sides flare outward at an angle of approximately 60 deg. with the face of the head. This is used for cutting keyways of convenient shape for the cement mortar keys, which prevent the timbers from slipping along contact faces. It also cuts the grooves part way across the notched face of the timbers, which are filled with the cement mortar, to bond timber and concrete slab in a way that will resist any overturning moment. Before the keyways are filled with mortar they are thoroughly soaked and the mortar is then tamped in a very dry state.

The 12x14-in. timbers on which the cutter heads operate are of two lengths, 40 and 60 ft. They are moved up under the cutter on rollers set in an 80-ft. bench to which timbers are brought from an adjacent storage pile by a pair of chain blocks mounted overhead on trolleys. Mounted in the bench is a hydraulic jack and a hinged circular frame so designed that the frame can be bolted around the timber and then the timber jacked up clear of the bench in order that it may be rotated easily by hand. This device saves much labor in turning the timbers over for cutting the opposite faces.

The cutter-head equipment and mounting were built at a cost of less than $500 by the Stetson-Ross Machine Co., of Seattle. The Railroad Ave. seawall was described in *ENR,* Nov. 8, 1934, p. 579.

SPECIAL CUTTER, motor-driven and adjustable for angle and depth, is used for notching timbers (right), to improve bond to concrete slabs.



Letters to the Editor

Tarred Stone Roads

Sir—An article by John S. Crandell, professor of highway engineering, University of Illinois (*ENR*, Dec. 22, 1932), described the construction of tarred-stone roads in Champaign County, Ill. The article closed by recommending that the "Roadbuilding fraternity watch these roads to see if they perform satisfactorily."

Only a few of the roadbuilding fraternity among your readers have had an opportunity to watch the roads as recommended, and a report on their performance may be of interest to the others. The following refers to the two roads near Urbana, Ill. The third, near Tolono, Ill., has not come under the writer's observation:

SURFACE CONDITION of South Race St. Urbana, Ill., after two years of service.

Neither road carries heavy traffic, as it is on the township or tertiary system. Too short for much traffic to originate among them, the loads they carry during bad weather, when subgrade conditions are bad, are limited by the condition of the dirt roads with which they connect.

In spite of this, both roads began to show some distress in 1933. By the spring of 1934, the condition was as shown by the accompanying illustration, and the county board authorized resurfacing.

One of the roads, South Race St., was resurfaced in September, 1934, at a cost of 18c. per sq. yd. The other road has not yet been resurfaced but is raveling badly and has developed periodic transverse corrugations. The resurfacing on South Race St., now about three months old, is beginning to peel off.

It is apparent that the roads are not rendering satisfactory service, even for the extremely light traffic that they carry. They were built at a per-mile cost almost exactly equal to that of single-lane concrete, of which Champaign County built over 24 miles that same year. The concrete road cost included $4,600 per mile for grading, structures, etc., as against less than $300 for the same items on the tarred-stone roads. Champaign County has found single-lane concrete satisfactory on roads carrying more traffic than these roads carry.

T. C. Kellogg.

Champaign, Ill.,
Jan. 30, 1933.

Future Mapping of the United States

Sir—The article "Preparing New Maps of the Tennessee River Basin" by T. P. Pendleton, of the U. S. Geological Survey, in your issue of Feb. 14, is of special interest in view of its possible bearing on the program for completing within ten years the standard base map of the United States. The mapping procedure in the Tennessee Basin gives an indication of the practice that may be followed in the larger mapping program.

Now would seem an appropriate time for engineers and the public to discuss fully just what type of map will be most beneficial to them, so that those placed in charge of the execution of this work may know what the public wants, enabling them to plan intelligently to meet the need. It is no small task to design a map costing $120,000,000 so that it best serves the map-using public. The burden of this task is increased if the map users keep quiet about its requirements. Because the official in charge of the project is an efficient map maker, it does not necessarily follow that he is sufficiently familiar with the multitudinous engineering needs to plan a map that will best serve those needs without any help from the prospective users. Your paper could perform a valuable service in stimulating discussion and promulgating information on this subject.

Under the heading "Selection of Scale," Mr. Pendleton states, "The most useful scale for mapping an area where so many needs must be satisfied would be one that would best serve the requirements of the most detailed study to be undertaken by the Tennessee Valley Authority." I for one believe that this criterion for the selection of the map scale for a large area is entirely wrong in principle. It is one that would result in the production of an almost useless map, when considering the area as an entirety and would entail an enormous expenditure of time and money.

The most detailed studies of certain limited areas to be undertaken by the Tennessee Valley Authority will require maps on the scale of 1 in. equals 40 ft. with 1-ft. contours. Other studies will require maps on scales of 100 and 200 ft. to the inch. The total area covered by these requirements will not exceed ½ of 1 per cent of the total area to be mapped. A map of the total area on any one of these scales would not be a useful map. The multiplicity of map sheets, the limited area contained on any one of them or on any manageable combination of them would be so small as to defeat their usefulness in planning the area as an entirety.

The map scale for large areas must be such that the interrelationship of the main characteristics of the area may be visualized and general plans for the problems presented be formulated, from which may be determined where detailed large-scale surveys should be made of needed special areas.

Under the heading "Aerial Photography" Mr. Pendleton tells why the five-lens camera was selected rather than the single lens for the aerial photographic work. It seems to me he decides in rather a casual way a mooted question of mapping utility and economy. There is a decided diversity of opinion concerning the relative merits of the two cameras; the subject merits fuller elucidation. Question arises concerning the quality of the resulting maps, relative costs as to the compilation of the photographic data and the comparative value for other uses of the photographs. These differences are such that they may many times outweigh any slight difference in original photographic cost that may theoretically exist in favor of the five-lens camera. I say theoretical difference because my examination of actual contracts for photographic work by the two methods does not show any actual difference in favor of the five lens. It is only fair, however, to say that my observation does not cover the entire number of contracts for aerial photography during the past two years; a complete tabulation of these, if possible, would be more conclusive on this point.

I hope Mr. Pendleton will discuss more fully this matter of cost by the method used on the Tennessee River Basin, giving the costs separately of flying and ground control, including photographic tie points, radial control, map compilation, field inspection and correction. In view of his published statement in favor of a particular method, it would seem that simple justice to those who have their capital and time tied up in the other method would dictate his giving full data in the matter.

W. N. Brown,
W. N. Brown, Inc.,
Engineers.

Washington, D. C.,
Feb. 20, 1935.

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March 14, 1935

Vital Help

WHAT is to be the final shape of the construction bill—in newspaper language the "work-relief" bill—still remains obscure. But it is already clear that its operation will depend in no small degree on the actual facts of present construction. Statistics on construction activity, wage payments and rates are essential information for most effective administration of the terms of the act. This condition gives special meaning to the questionnaire inquiry now under way by the Construction Code Authority. Copies have been sent to every contractor on the Authority's list, and it is important that fullest response be obtained to make the returns of immediate service in promoting the recovery construction campaign, over and above their use in the service of code administration. By filling out the questionnaire promptly —or by asking for a copy if none has been received—contractors will give vital help to the season's major recovery campaign.

Progress at Chicago

THE CALL FOR BIDS on Chicago's Southwest sewage-treatment plant, advertised last week, marks a significant event in the field of community sanitation. When the construction of the plant gets under way, a physical start will have been made on facilities for subjecting to treatment all the sewage of the district, from a population of more than 4,000,000. The 200-m.g.d. activated-sludge plant for the North Side has been in operation since 1928. The West Side Imhoff-tank plant has been operating since 1930, and when additions now under way are completed will have a capacity for partial treatment of 500 m.g.d. Work now in progress on the Calumet plant will bring it to 136 m.g.d. With four plants of aggregate capacity 1,250 m.g.d. Chicago will soon present the unusual but gratifying picture of a major metropolis doing its utmost to relieve the harmful consequences of its community wastes.

Guard-Rails, Not Railings

ON TWO OCCASIONS last week motor cars crashed through bridge railings in New York City, falling to the street below, though—miraculously—no one was killed. Such accidents, like those at railroad grade-crossings, occur much too frequently. Elimination of railroad grade-crossings, however, is an expensive and difficult operation, whereas elimination of weak bridge rails is both simple and inexpensive. In spite of some notable exceptions, bridge engineers have not yet taken the bridge rail seriously enough. For one reason, it is still regarded as a railing and not as a guard-rail. For another, it is too often an architectural plaything, with the result that appearance and not safety is the paramount consideration. Most of the inadequate guard-rails occur on old bridges, and every practicable means of strengthening them should be exhausted. On new bridges high double curbs are useful, but it is necessary to recognize that the speeding automobile and the heavy truck approximate the famous irresistible force. The guard-rail, then, should resemble the equally famous immovable object.

The Watchdog Under Attack

THE ACTION of the President's cabinet in declaring independence of Comptroller-General John R. McCarl in a matter of approving traveling expenses is important in the light of recent efforts by a clique in the construction industry to transfer some of his powers to federal department and bureau heads. Neither engineering nor contracting have anything to gain by enlisting in such a movement. Granting that irritation arises on occasion because of the sharp scrutiny and rigid exactions of the comptroller-general's office, that office has put federal public-works contracting on the highest plane of rectitude and efficiency that it has ever occupied. The constructor who has chafed at the precision with which decision on his plans has hewed to statutory lines has always been assured that his competitors have not been excepted; no favorites have enjoyed the consideration of the paymaster. It means far more to the growth of a stabilized construction business to have this rigid determination of open and free competition than not to have it. And the protection of the public, which is the first consideration, is better ensured. There is value in that independent check on federal contracting agencies which Congress had in mind when, fifteen years ago, it set up the budget office and the comptroller-general.

Private Housing Money

THE RECENT APPROVAL by the Federal Housing Administration of two limited-dividend housing projects —in Washington, D. C., and Meadville, Pa.—provides a view into a realm of inviting possibilities. It is private money and private initiative that are involved in these loans, the government merely acting as a mortgage insurance company under the terms of the National Housing Act. There is, therefore, engendered the hope that these projects may be harbingers of a spring thaw in the mortgage money market. Without such a thaw the large-scale movement for low-cost housing seems destined to drift, as it is doing now, with accomplishment so far in the future that present business recovery can receive no help. Some action in the private investment market might also inject new vitality into the local housing Councils and Authorities who have marked time while waiting for the federal government to finance them instead of initiating those city-plan studies and public-education movements that are indispensable to any real progress in housing. The earmarking of $450,000,000 for housing in the new work-relief bill is therefore not as significant as it should be, for delays in spending it seem inevitable. If private building, however, can be encouraged in large volume, government-subsidized housing may not be required for business recovery.

Scour at Overfall Dams

HOW TO MAKE HARMLESS the energy liberated at the foot of an overfall dam is a problem long recognized and long a field of study and invention, but still one of the points of greatest perplexity and uncertainty of knowledge in hydraulic engineering. The huge dimensions that the problem often assumes may be grasped when it is considered that the maximum flood overflow at Grand Coulee high dam will release energy at the foot of the dam at the rate of some 30,000,000 hp. This kinetic energy must be destroyed by transformation into heat, not merely diverted by changing its direction; the belief that turning the downward falling water into horizontal direction by a curved apron in the hope that somehow or other the energy would dissipate itself harmlessly has often enough been proved fallacious by destructive scour and undermining at the end of the apron. Some type of eddy formation is essential for the required energy destruction, an action well explored nearly twenty years ago in the stilling-pool researches of the Miami Conservancy District. The survey of practice given by Lane and Bingham in this issue presents a broad picture of the developing art in this field. Various devices for producing turbulence have been used in different cases, from random obstructions to regularly shaped notchings and toothed sills. These, however, are typically nothing more than auxiliaries to the hydraulic jump, something to localize it under varying flow conditions. Thorough understanding of jump formation is at the root of scour prevention.

The Menace of Silicosis

GROWING CONCERN about the insidious rock-dust disease, silicosis, has progressively brought about a situation in which ignorance, weak efforts at control and the threatening complication of racketeering combine to bedevil both industry and worker. Each day the situation grows worse, and it is high time that it be dealt with by determined action.

Recent news reports carry significant information about silicosis damage suits. In Missouri an aroused mining industry has just obtained a number of grand jury indictments against two lawyers active in silicosis cases on charges of barratry (inciting of law suits). A Missouri lime company is seeking receivership to protect its assets against silicosis judgments. A mine workers' union in Butte has petitioned the U. S. Senate for a sweeping investigation of the dust hazard in mines. And in the field of construction an able and reputable contractor is starting his third campaign of defense against a multitude of suits arising out of the driving of a three-mile tunnel in West Virginia.

Industry's bewildered, helpless and planless attitude toward silicosis is aggravated by scientific ignorance. Experts who have studied the disease for years agree only in recognizing that the hazard exists. Industry thus is faced with several major problems, chief among them knowledge of cause, development of effective means of prevention, and detection of the conditions that favor silicosis.

As to diagnosis and knowledge of cause, medical ignorance is great. Most authorities hold that silicosis is a fibrosis of the lungs caused by exposure to dusts containing high concentrations of free silica particles less than 10 microns in size. But a British geologist claims that the cause is not silica but sericite, a fibrous mineral of the muscovite family. Other authorities regard all dusts as potentially harmful. Some claim that silicosis cannot develop in a normal lung free of other infection, such as tuberculosis. There is disagreement as to the length of exposure required to contract the disease and the time required for its development. The U. S. Public Health Service states that there is danger in any atmosphere that contains more than 5,000,000 of the fine silica particles per cubic foot. And finally, medical experts claim that few doctors are capable of diagnosing silicosis.

Prevention is a field of even greater ignorance. Meetings called to consider methods of protecting rock workers almost uniformly fail to bring out definite proposals, and when some device or method is suggested by one speaker it is promptly condemned by another.

If rock dust causes silicosis, effective control of such dust should give protection. But what form of control? Thorough ventilation is advocated, but the first silicosis suits in construction come from an amply ventilated tunnel job. Free use of water is advised—wet-drilling, spraying, and the like. Yet in the Rand mines in South Africa, where such measures are in common use, silicosis is rampant. Control of the drill dust at the drill hole is recommended, but there is no apparatus for this purpose in commercial production today, and even if it were available and effective it would still leave the dust created by blasting, mucking and other rock-removal operations uncontrolled. Perhaps a solution is offered by the stringent specifications for respirators recently drafted by the Bureau of Mines and successfully met by three manufacturers. Respirators have so long been considered useless that the development of an effective mask is encouraging.

It may be that no single preventive measure is sufficient, and that a combination of two or more will be required. Here, however, we have the third problem. How can a contractor, for example, determine whether his work involves silicosis-dangerous dusts, or whether the kind and amount of dust is such as to expose workmen to the disease? No simple method of analysis is available. Before we can get far in the silicosis fight such methods must be developed.

A final problem is that of compensation laws. Four states now include silicosis in blanket industrial-disease clauses in their compensation acts. Two other states have special insurance funds to which employers may voluntarily subscribe for protection against silicosis suits. In several states legislatures are now considering silicosis compensation acts. Yet no single silicosis compensation act so far passed or proposed provides fair protection of labor and industry alike. Insurance executives warn that industry should avoid the delusion that the silicosis problem can be solved by insurance except at a very heavy cost. And most troublesome of all is the fact that silicosis develops so slowly—often after many years, apparently—as to make it almost impossible to determine responsibility with sureness.

This brief summary reveals the gravity and the magnitude of the situation. The problem is too big for any one individual or firm, even for a single group or industry. It demands the attention of a national organization. Perhaps the Bureau of Mines, if given adequate funds for thorough investigation, could show the way to a solution. The present uncoordinated activities of industrial hygienists, public health authorities, labor, law-making bodies and industries themselves are bringing no results. Coordinated and ably directed, however, they are certain to move forward toward a solution of the problem.

CURRENT NEWS

Code Authority Favors Continuing A Modified NRA

ASSERTING that the NRA has been an important factor in the progress toward recovery of all industry, that the rehabilitation of the construction industry has been begun under the construction code and can be further effected if the code is continued, the Construction Code Authority at its meeting in Washington, March 8, urged that the National Industrial Recovery Act, with proper changes, be extended for a period of at least 2 years. In the resolution the code authority recommended that the new bill, contain a provision granting immunity from civil or criminal liability to a code authority, or the members thereof, when acting within scope of their authority, and that appropriate enforcement of codes by other than criminal action in courts be included and other changes made found necessary through experience. The executive committee was authorized to present this resolution to, and represent the Code Authority before the Congressional committees dealing with extension of the pending measure.

Various suggestions were made at the meeting as to changes demanded by experience in the content of the act, or its administration. It was emphasized that active and energetic enforcement was a necessary requirement to proper administration by code authorities, and that government compliance with the provisions of codes was essential to insure adherence on private work.

The meeting discussed the recommended program of joint facilities for local integration of the construction code administration which has been developed after several months' study, and has been recently submitted to the divisional code authorities following its approval in principle by the Construction Code Authority. Prof. William S. Carpenter of Princeton University, who with Prof. Harwood L. Childs of the same institution has been advising the code authority in the preparation of this program, was present and explained the salient features of the program, including the setup of the local code council which would complement the actions of divisional administrative committees.

Questionnaire returns

A report stated that the statistical questionnaire on employment conditions is producing valuable data of particular use in the planning and execution of the work-relief program. In spite of the fact that the mailing of questionnaires to more than 100,000 contractors had just been completed, 10,000 returns have already been received. The work of summarizing the results, however, cannot be undertaken until the returns are more complete, and an appeal was made to the divisional groups and members of the industry to expedite the returns so that the actual conditions throughout the industry will be reflected in the summaries.

Ickes-Moses Controversy Ends, Triborough Bridge Gets Funds

By interpreting Administrative Order 129 as non-retroactive, Secretary Ickes, in a letter sent to Mayor LaGuardia of New York City, conceded the continuance of Robert Moses, New York City Park Commissioner, as a member of the Triborough Bridge Authority. Order 129 makes it impossible for any city official to serve on an authority administering PWA funds. At the same time, the PWA released $1,600,000 of funds which will permit the continuance of construction operations on the $42,000,000 Triborough Bridge project.

The controversy between Mr. Moses and Secretary Ickes has been an important issue in New York City, with public opinion backing Mr. Moses, on the basis of his generally recognized competence, his splendid record as head of the Long Island State Park Commission and because of the obvious advantages of integrating the Triborough Bridge work and city park and parkway planning. For a number of weeks Secretary Ickes stood firm on his ruling that Mr. Moses would either have to give up his position on the Authority or as city park commissioner. As long as funds for the continuing of construction operations on the Triborough Bridge were available, the matter did not reach a showdown.

Recently, the bridge authority needed to secure another installment of funds from the PWA, and the decision of Secretary Ickes permitting Mr. Moses to continue on the Triborough Bridge Authority ended the weeks of uncertainty over the possibility of work being stopped.

Although exempting Commissioner Moses and Tenement House Commissioner Post by his interpretation that the order was non-retroactive, Secretary Ickes announced that it would be strictly applied in future cases.

Bid Depositories Established for New York Building Contractors

The New York State Administrative Agency of the Divisional Code Authority for General Contractors has established bid depositories throughout the state at which duplicate copies of all bids submitted by general contractors for building construction must be filed. The depository plan goes into effect March 15 and is mandatory upon all general contractors. It applies only to building work in excess of $1,000 in value, and federal projects are exempt. Duplicate bids must be filed at a depository or mailed for filing prior to the time set for opening of bids by the awarding authority. A filing fee of $2 must accompany the duplicate bid. The state has been divided into four regional zones, with one or more depository offices established in each zone.

Copies of the regulations and a list of depository offices may be secured from the New York Administrative Agency, Room 614, 230 Park Ave., New York City.

Contractors Assured Participation In Works Program

(Washington Correspondence)

PRESIDENT ROOSEVELT has assured the construction industry that its personnel and equipment will be used in carrying out the work-relief program. Regardless of the form which the legislation finally takes, nothing is likely to interfere with the President's plan as tentatively outlined to a delegation representing the Construction Code Authority, the Construction League, and the Building Trades Unions. An amendment sponsored by Senator Glass, in charge of the bill, to extend the life of the Public Works Administration for two years so that there may be no confusion concerning the completion of projects to which it is committed, also has removed apprehension that the service of private contractors would be dispensed with.

It is understood that the President contemplates employment of contractors on a fee basis. This implies, in turn, that the government will purchase materials for all projects and draw labor from relief rolls. In as much as Michael McDonough, representing the Building Trades Department, of the A. F. of L., joined with John Hogan, chairman of the Construction League, in a statement endorsing the President's plan, it is assumed that the President has devised a practicable method of protecting prevailing wage rates in private employment. This may take the form of paying prevailing rates on work-relief projects to such skilled labor as relief rolls cannot supply.

Administrator Ickes regards as entirely satisfactory the allocation of the $4,000,000,000 appropriation to the several types of work specified in the bill as reported from the Senate Appropriations Committee. He mentioned particularly the desirability of providing funds for reclamation and as loans for railroad equipment and other improvements.

Bill before Senate

The Administration's works relief bill is back on the floor of the Senate (March 13) for consideration after being amended in its second consideration by the Committee on Appropriations. In re-submitting the bill to the Senate, the committee, through Chairman Glass, recommended the following important changes in the first section of the bill.

> "It is recommended by the committee that the following language be stricken from section 1 of the [original] resolution: 'protect and to promote the general welfare, by (1) providing relief from the hardships attributable to widespread unemployment and conditions resulting therefrom, (2) relieving economic maladjustments, (3) alleviating distress, and/or (4) improving living and working conditions,' and the words *'provide relief and work relief'* inserted in lieu thereof.
>
> "It is recommended by the committee that the following provision allocating

the $4,000,000,000 appropriated by the joint resolution be inserted:

> "Provided, That except as to such part of the appropriation made herein as the President may deem necessary for continuing relief as authorized under the Federal Emergency Relief Act of 1933, as amended, this appropriation shall be available for the following classes of projects, and the amounts to be expended for each class shall not, except as hereinafter provided, exceed the respective amounts stated, viz: highways, roads, streets, and grade-crossing elimination, $800,000,000; rural rehabilitation and relief in stricken agricultural areas, $500,000,000; rural electrification, $100,000,000; housing $450,000,000; projects for professional and clerical persons, $300,000,000; Civilian Conservation Corps, $600,000,000; public projects of States or political subdivisions thereof, $900,000,000; sanitation, prevention of soil erosion, reforestation, forestation, flood control, and miscellaneous projects, $350,000,000: Provided further, That not to exceed twenty percentum of the amount herein appropriated may be used by the President to increase any one or more of the foregoing limitations if he finds it necessary to do so in order to effectuate the purpose of this joint resolution."

The committee also recommended that the following section with reference to the rate of wages be inserted in the bill:

> "The President is authorized to fix the rates of wages of all persons compensated out of the funds appropriated by this joint resolution and may fix different rates for various types of work, which rates need not be uniform throughout the United States.
>
> "In the event the President, or such official or agency of Government as he may select, shall determine after an investigation that the rate of wages paid is affecting adversely or is likely to decrease the prevailing rates of wages paid for any work of a similar nature in any city, town, village, or other civil division of the state in which the work is located, the President shall immediately fix the rate of wages at an amount not less than the prevailing rate of wages paid for work of a similar nature in such locality."

Plans for Making Chicago Fair Permanent Institution

Construction work costing $20,000,000 would result if the proposed plan to make the Chicago Century of Progress a permanent institution materialize along the lines proposed by Mayor Kelly of Chicago. The carrying out of this program will depend upon the work relief program of the federal government, now pending in Congress, and the possibility of securing this means for financing the work.

The principal item in the construction program would be the building of a $7,000,000 exhibition hall which would house agricultural and industrial exhibits and have a convention hall of 50,000 seating capacity. The program would anticipate the earnings of the permanent fair paying for the federal financing.

Beach Preservation Association to Hold Meeting at Miami

The spring meeting of the American Shore and Beach Preservation Association will be held April 5 at Miami, Fla., in conjunction with the meeting of the Florida Engineering Society. At the morning session of the meeting an address is scheduled to be given by Arthur S. Tuttle, president of the American Society of Civil Engineers. A group of five major papers will be presented covering various phases of coast erosion and protection, and an inspection trip has been arranged to visit the local beaches.

IN WASHINGTON

By Paul Wooton

Washington Correspondent

Plans for Administering the work-relief act are well advanced. The force account specter is definitely laid. Contractors, with their equipment and their key men, will be employed on a fee basis. Materials will be bought directly by the government in the largest possible quantities.

The types of highways to be constructed under the work-relief act will be left entirely to the state highway commissions. The President himself is authority for the statement that hand labor will not be required to the point of being wasteful. This is interpreted as meaning larger use of machinery. The Administration is definitely fed up on raking leaves.

Administration of the work-relief act will be in the hands of three boards, according to the plan as it stands at present. The President himself will head the board which deals with allocations and the major questions of policy. Another board will keep behind every allocation to insure rapid progress. A third board will receive applications and complaints.

To insure that the button-hole maker is not assigned to a construction job, the adjustment board of the Construction Code Authority is now engaged with three Public Works officials in the formulation of a plan for the classification of labor on relief rolls.

A new system of mortgage loans for income producing real estate property is to be set up by the Reconstruction Finance Corporation.

Boulder Dam Reservoir Silting to be Studied by New Program

As a preliminary to possible steps for protecting the Boulder Dam Reservoir from destructive silting, the Soil Erosion Service, in cooperation with the Bureau of Reclamation, has announced plans for maintaining a constant check on the amount of sediment and other debris which will be deposited in the reservoir site during the coming years. The first step in this program will be the preparation of a map by the U. S. Coast and Geodetic Survey of the 230 sq. mi. which will be flooded by the reservoir. This map showing the original contours of the reservoir site will form the basis for the future comparative studies to determine the change in topography of the lake floor as a result of silting. From the information obtained by this program, a basis will be formed for the necessary protective measures in erosion control and silt detention in the water shed area of the Colorado River and the tributaries of the stream.

Based on previous studies which were made by the engineers of the Bureau of Reclamation, during the planning of the Boulder Dam project, it was estimated that during the first 50 years of operation, about 3,000,000 acre-feet of silt will be deposited in the reservoir, or 10 per cent of the reservoir capacity. An allowance of 10,000,000 acre-feet for silt retention has been made in the Boulder Dam plan and it is estimated that more than 150 years will be required for this volume of silt to be deposited with something like 500 years to elapse before the 30,000,000-acre-ft. reservoir would be completely filled with silt.

GOLDEN GATE BRIDGE CAISSON GOES TO WATERY GRAVE

"MISFORTUNE to the bitter end" was the lot of the caisson that had been intended for use on the south pier of the Golden Gate Bridge but never served that purpose and eventually was sunk in the Pacific, 30 miles offshore on March 5.

For months last year the 90x180-ft. caisson with 4,000 cu.yd. of concrete ballast tugged at its mooring awaiting completion of pier foundation work. Finally the south pier fender ring was ready and on Oct. 9 skillful tug operators, with the aid of some profanity, it is reported, succeeded in coaxing the caisson into place (*ENR*, Oct. 25, p. 541). Confinement was irksome and the caisson fought so forcefully that on the same day disgusted tug boat captains were ordered to remove it. On its way home, evidently determined to have its fling, the caisson defied the tugs and crashed a pier of the San Francisco-Oakland Bay Bridge.

With the modified foundation program which eliminated the use of the caisson it became a useless expense and the cheapest obsequies would be to dynamite it into a watery grave. On March 4 two sturdy tugs took the caisson in tow and headed out the Golden Gate where, it is reported on good authority, the caisson thumbed its nose at the south pier. Every inch of the way the caisson balked and plunged.

As night fell, after a 12-hr. tow, it was only 5 miles offshore. Then Father Neptune slapped the blunt nose with a wave, whereupon the caisson yanked back forcefully, broke a towing cable and gleefully went "on the loose" for a wild night. Headlines announced "Dynamite-laden Caisson, Adrift, Perils Ships."

Came the dawn—and more tow lines. Thirty miles out the explosive charge was detonated and Tony, tug captain, pronounced the benediction (?). Interviewed later, he reported: "Damn box, she go boom, sink."

Six Companies Inc. Protests Payroll Seizure in Telegram to Ickes

In a VIGOROUS protest against the recent action of the Department of Justice in seizing payroll records of Six Companies Inc. at Boulder Dam, Henry J. Kaiser, Chairman of the Executive Committee of the contracting firm, stated his position in a telegram to Secretary of Interior Ickes. As noted in these pages last week, the records were impounded by Department of Justice agents following alleged charges of a former employee of the contractors that the eight-hour law is constantly being violated and that a secret payroll is kept for overtime work. Mr. Kaiser's telegram, released by Six Companies Inc., follows in part.

"Recently the Administration has permitted releases to the newspapers which infer that Six Companies Inc. has dishonestly kept certain payrolls secretly, which information was obtained from a discharged employee. It is inconceivable that the 300 representatives (of the Dept. of Interior employed here) would fail to have knowledge of those employees who have worked overtime. The majority of these government representatives understand the emergency situation involved in constructing a project of the magnitude of Boulder Dam. Thirty million hours have been consumed by the workers of Boulder Dam in the past four years. Your forces have indicated only *229* cases, which, apparently in their opinion have been avoidable, since this is the total number of cases for which we have been penalized.

"For at least twenty years the law governing emergency overtime has been in existence. Under these circumstances, undoubtedly, every construction department of the government has been compelled to do some emergency work. Upon investigation of the thousands of projects done under this law, the resulting comparisons, on the average, I believe, will show that the Six Companies Inc. have done, in proportion less emergency work, even though Boulder Dam is the most hazardous project the world has ever known. Six Companies Inc. work three shifts of 8 hours per day. The men are paid for 8 hours even though they actually work less hours than this, due to the fact that they are paid for the time consumed while they are having their meals during meal time on the work. The public should credit the Six Companies Inc. for this liberal act, rather than condemn, and when the public is so aware I am certain Six Companies Inc. will be credited.

"Their accounting practice is such that they carry three payrolls, not two, as the Administration releases to the newspapers would indicate. One payroll carries the office and incidental payrolls, the second payroll is the regular payroll, the third payroll covers emergency and bonus payrolls. The bonus payroll covers hours which the men have not worked but is carried in a form of converting into dollars, bonuses which the men have been paid when they have exceeded a normal day's work by successfully putting additional buckets of concrete into the dam, in a period of 8 hours. In such cases, although they have worked only 8 hours, they are paid for 9 or 10 hours, as the case may be. Certainly this is giving the men an incentive for profit and follows the principle which the President of the United States has indicated his approval of. On this emergency and bonus payroll over 30,000 checks have been issued and this certainly, in itself, is an indication that no secrecy or dishonesty was involved on this emergency.

"Specifically, with reference to that damning word called secrecy, which the newspapers of the United States have carried and which has resulted in damaging and blackening the reputation of the Six Companies Inc. so it is doubtful if they can ever recover because the public does not ordinarily follow any specific case through to conclusion, wherein they read both sides before judgment takes place. The secrecy claimed is totally without foundation.

"Upon a very simple investigation it will be found that we have: First, written each month to the government, giving the total of our payroll. Second, written many months ago to the government stating that the payrolls were open to their inspection. Third, furnished the government each month with the total amount of all labor paid, and monthly furnished them with unit costs of each item constructed.

"Your department has never been refused any information and the Six Companies Inc. has conducted itself so that all of its records have been public to you. May we advise you also, that the Department of Justice, in the seizure of records, took only a part of our records and that it did not take the records showing conclusively that part of the so-called overtime was in fact bonuses, nor did it take records showing the occupation in which the men were employed. We have since voluntarily delivered to them records they did not know existed. We have in our office a truck load of time cards which will be necessary to obtain the information needed for full investigation, and you are welcome to these. The inference of dishonesty given to the world throws a dark shadow over the lives of the hundreds of officials and engineers of the Interior Department who are supervising this great construction venture, Boulder Dam, and this reflection on your department should be removed until the total evidence has been carefully reviewed by you. It is inconceivable that these hundreds of men representing the Government, who knew the provisions of the Boulder Dam contract, in detail, should fail to report hours of labor worked contrary to the provisions of the contract."

Prof. Michael Pupin Dies: Renowned in Electrical Field

Prof. Michael Idvorsky Pupin, internationally known physicist and inventor, and a past chairman of the Engineering Foundation, died in New York City March 12 at the age of 77. He had served on the faculty of Columbia University continuously from 1890 until 1931 when he retired as Professor Emeritus of Electro-Mechanics. Professor Pupin's career since the day he landed as a poor immigrant boy in 1874 is well known. Most of his work was in the field of telephonic communication, radio and X-ray. In 1932 he received the John Fritz Medal as one of the many honors which were conferred upon him by universities, scientific societies and governments.

A.S.T.M. Committees Hold Meetings at Regional Convention

WITH well attended sessions and a total registration of more than 600, the spring regional meeting of the American Society of Testing Materials held in Philadelphia March 4-8 included about 130 meetings of committees, sections and subcommittees. As a result of these committee meetings, a large number of proposed standards were offered for approval and several specifications and test methods which have been in a tentative stage were recommended to the society for adoption as standard. Several new committees will be organized as a result of action taken by existing groups. The general session of the meeting was devoted to a symposium on paint and paint materials which included 15 papers.

Committee A-1 on steel acted to revise the specifications covering open-hearth carbon-steel rails to include details of drop testing equipment and a definite descriptive revision covering O and M positions. The committee on wrought iron has completed the preparation of two new specifications for wrought iron sheet covering black and galvanized sheet material.

Committee C-3 on Brick

Two technical papers were presented at the sub-committee meeting on weathering and porosity of brick describing studies which will prove valuable in connection with the work of Committee C-3 on brick. The work of this sub-committee has resulted in the development of a method by which the weathering resistance of fire-clay bodies, such as brick in a wall, may be measured by definite tests. This procedure was approved for submission to letter ballot for inclusion in the new methods of testing brick which are to be issued during the year.

Further, the committee will undertake studies to determine the effect of de-airing on the physical properties of brick which, when completed, may result in improvements and changes in specifications for paving brick. A study will also be made of the specifications for sewer brick, and it is anticipated that this will result in various changes and improvements, which may be ready for consideration at the next meeting of the committee.

Metals at low temperatures

A new committee on the property of metals at low temperatures was organized as a sub-committee of the Joint Committee on Effect of Temperatures on the Properties of Metals. For the purpose of its work, the committee has defined low temperatures as any below room temperature (70 deg. F.) This subject was considered to be of great interest in many branches of the industry because of the subnormal temperatures at which construction equipment must work during certain periods of the year. The committee will send out a questionnaire to obtain information on what test and research work has been done and proposes to present a bibliography of this work for the consideration of the joint committee at its next meeting.

The annual convention of the A. S. T. M. will be held at Detroit, Mich., June 24-28.

Professional Development Council Reports Progress on Its Educational Program

At a joint meeting of the five metropolitan sections of the principal engineering societies held in New York on March 6, officers of the Engineers' Council for Professional Development outlined the progress that has been made to date by the council in laying down a logical program for the development of the profession. The principal speakers were C. F. Hirshfeld, chairman of the Council; R. I. Rees, chairman of the E.C.P.D. committee on professional training, and Prof. J W. Barker, member of the committee on professional recognition.

The present work of the council is handled by four committees:

(1) Student Selection and Guidance, with Dean R. L. Sackett as chairman. In its studies this committee has developed two tests that appear to be satisfactory in determining whether a boy is a potential engineer, but it feels that it has only made a beginning.

(2) Engineering Schools, with Karl T. Compton as chairman. This committee is now engaged in accrediting engineering schools, in the hope that ultimately its list of accredited schools will be accepted throughout the nation, instead of having the licensing boards of the several states set up their own lists of accredited schools. As the National Council of Boards of Engineering Examiners is represented on E.C.P.D., this work is being carried on in cooperation with the work of the National Council.

(3) Professional Training, with R. I. Rees as chairman. This committee is developing what Mr. Hirshfeld characterized as post-graduation studies to distinguish them from post-graduate work as generally understood.

(4) Professional Recognition, with Conrad N. Lauer of Philadelphia as chairman. This committee is outlining what an engineer must do to receive professional recognition.

General R. I. Rees, speaking on the matter of the training of the young engineer after graduation, stated that his committee ultimately hopes to lay down what are the fundamentals of a scholastic education for an engineer and what are the things he can most easily get after graduation. In the latter work a large amount of attention should be given to the humanities, but it must go hand in hand with further professional development.

The committee is endeavoring to do the following: (1) Develop a means of critical appraisal of a man's abilities; (2) Lay out a study program for long-time use; and (3) Lay down a program for immediate study, a program of about one year's time. The committee has prepared a bibliography of general reading, and are working on a professional bibliography.

Mr. Rees said that one important element of the committee's work would be advanced measurably if the senior engineers of the profession would express willingness to act as consultants to the juniors in their communities, to help them in their professional development. He proposed group consultation or individual advice on the problems of the younger men.

Dean J. W. Barker spoke on professional recognition and the enhancement of the engineer's status. Professional recognition as here used means the determination of minimum requirements for a man to be entitled to be recognized as engineer. It has outlined tentatively the amount of scholastic training required for a man who is able to enter the profession through that channel and the amount of practical experience required for such men, and it also has outlined the character of the training that a man must receive who enters the profession through the practical-experience route, the self-taught man. Ultimately, it hopes that E.C.P.D. will set up a system of certification, and that its certificate will be accepted by state license boards and by technical societies for minimum requirements for corporate membership. Such certification if put into effect nationally at the present time would require a "grandfather clause," and Dean Barker outlined how this was to be put into effect over a period of years.

Resignation and Removal Change Allegheny County Authority

Delay in launching the $24,165,000 PWA-financed work program of the Allegheny County Authority at Pittsburgh, Pa., is reported to be the principal reason for a major change in the authority by the county commissioners. After accepting the resignation of Press G. Dowler, Pittsburgh architect and chairman of the authority, the county commissioners, a few minutes later voted to remove E. N. Hunting, vice chairman of the authority and recently PWA examining engineer in Western Pennsylvania. Samuel Eckles, former chief engineer of the Pennsylvania Highway Department and John Race, consulting engineer, were immediately appointed by the county commissioners to fill the two $10,000-a-year vacancies in the authority.

Samuel Humphreys Yonge Dies; Long Career in River Work

Samuel Humphreys Yonge, retired, whose engineering career included almost six decades of work in the fields of bridge design and construction and Mississippi River control, died at Edenton, N. C., March 11, at the age of 94. Mr. Yonge was a descendent of Joshua Humphreys, who designed the frigate "Constitution."

Born at Savannah, Ga., he studied at Washington College and the University of Virginia. In 1869-72 he served on the construction of the Missouri River bridge in St. Charles, Mo., and was assistant engineer on the Baltimore Bridge Co. on design and construction during the next year. For the next 20 years he served on government work in river surveys and control operations on the Missouri and Ohio Rivers. During his work on the Missouri River, he is credited with developing a system of woven-mattress type of bank protection which has been used extensively on subsequent Mississippi River work. From 1899 to 1921 he was in charge of improvements on the James and Appomatox Rivers in Virginia and the construction of the seawall at Jamestown Island, Va.

Personals

F. W. Stopher has been made division engineer in Ohio highway division No. 2, with headquarters at Toledo.

Archie Ranney, former city engineer of Cuyahoga Falls, has been appointed Ravenna district engineer of the Ohio state highway department.

Harley Calvin, of Marietta, Ohio, has been named division engineer of state highway division No. 10, succeeding A. W. Sherwood.

Ray Crow, former chief engineer of the Alabama Relief Administration, has been appointed chief engineer of the Alabama Public Works Board.

Joseph N. Doyle, of Portsmouth, Ohio, has been appointed division engineer in the Ohio highway department, with headquarters at Chillicothe.

Major W. M. Hoge, Jr., formerly with the U. S. Engineer office at Memphis, Tenn., will be transferred to the Philippine Department about May 14.

W. R. Robertson, formerly assistant engineer, Ontario Hydro Electric Commission, has been appointed assistant chief engineer of the Canadian Pacific Railroad.

Fred N. Billingsley, consulting engineer, has been named president of the New Orleans chapter, American Society of Municipal Engineers, to succeed the late Bryson Vallas.

George Noble Carman will retire as director emeritus of Lewis Institute, Chicago, after completing forty years of service, Sept. 1, 1935. His successor has not been named.

Frank C. McCulloch, attorney, of Baker, Ore., has been appointed public utilities commissioner of Oregon's one-man utilities commission by Governor Charles H. Martin. He succeeds Charles M. Thomas.

E. M. Fleming has been appointed district manager in charge of the New York office of the Portland Cement Association. For the last six years Mr. Fleming has been manager of the Highways and Municipal Bureau of the Chicago office of the association. He was formerly with the Illinois division of highways.

Lee G. Warren has been appointed construction manager for the building of the large Tygart Reservoir Dam at Grafton, W. Va., by the Frederick Snare Corp., New York, contractor on the project. Mr. Warren has been in charge of construction of several large dams in the past, including the Carpenter Dam near Hot Springs, Ark., and the Jordan Dam in Alabama.

Paul Polisson has been elected city engineer of Gloucester, Mass., to fill the unexpired term of the late John H. Griffin, who died in Florida in January. Mr. Polisson served three years as an engineer in the street department of the Massachusetts department of public works prior to an appointment as engineer with the ERA planning board for Gloucester.

William M. Spann, who has been chief engineer examiner for the Public Works Administration in Missouri, has succeeded Col. Hugh Miller as PWA state engineer for Missouri. Former positions held by Mr. Spann have included those of chief engineer of construction for the Missouri state highway department, city engineer for St. Joseph, Mo., and chief engineer for the Jackson County highway department.

J. R. BURKEY, ELMER HITLY AND IVAN R. AULT have been reappointed to office in the Ohio state highway department for a term of two years. Mr. Burkey continues as chief engineer of bridges, Mr. Hitly as chief engineer of construction, and Mr. Ault as division engineer at Ashland.

Obituary

THOMAS J. DONNELLAN, deputy health commissioner of Boston, Mass., from 1924 to 1933, and for 42 years an employee of the department, died in St. Petersburg, Fla., on March 6. He was 71 years of age.

CHARLES E. HOPPS, 48 years old, formerly engaged in the contracting business but recently employed as inspecting engineer on new construction work being done at the University of Maryland, died suddenly on March 1 at his home in Towson, Md.

WILLIAM E. ATKINSON, former chairman of the Louisiana highway commission and one of the most widely known civil engineers in Louisiana, died at his home in Ruston, La., March 1, at the age of 57. He was a native of Whitesburg, Ga., and a graduate of Louisiana State University.

CHARLES SIMPSON KEIFER, associate engineer with the Memphis District U. S. Engineer Office, died March 3 at the age of 53, after a six weeks' illness. He was for nineteen years associated with the U. S. engineers and for the past thirteen years was at Memphis. He was a native of Illinois and graduated from the Armour Institute of Technology.

FRANK J. LYNCH, Brooklyn Borough engineer and an active member of the Brooklyn Engineers Club, died March 6 in Mount Vernon, N. Y. Mr. Lynch was born in New York in 1882 and was graduated from Manhattan College. He served with the department of bridges from 1903 to 1913. In 1934 he was put in charge of the TERA construction work in the borough of Brooklyn.

T. MCCABE BROWN, inspector-engineer for the Dallas, Tex., area of the Public Works Administration, died March 3 of injuries sustained in an automobile accident. He was one of the designing engineers for Lake Dallas and was also designing engineer on the Bachman pumping station. He had been associated with the city water department and with private contracting work.

CONSTRUCTION STATISTICS OF THE WEEK

AN INCREASE in public engineering construction awards raises this week's volume to $27,721,000. Private awards total $4,963,000 while public awards total $22,758,000, $5,933,000 for federal work and $16,825,000 for state and municipal.

Highway awards at $4,950,000 dropped back slightly from last week, industrial buildings dropped back to $1,576,000 from last week's high volume, bridges dropped back to $1,278,000. All other classes of work were higher than last week: waterworks at $572,000; sewerage at $1,303,000; commercial buildings at $2,732,000; public buildings at $5,904,000; earthwork, irrigation, waterways at $3,959,000; and unclassified at $5,447,000.

The larger awards for the week include administration and science building for Mt. St. Joseph College, West Hartford, Conn., $600,000; senior high school, Bayonne, N. J., $1,250,000; Stephen Collins Foster Memorial Bldg., University of Pittsburgh, Pa., $500,000; highway lettings by Illinois, $935,000 and by Texas, $656,000. In Cleveland, Ohio, the concrete blower building for sewage disposal plant was awarded at $514,000. Large federal awards included 7,730,000 cu.yd. earthwork in White River Levee Dist., Ark., $1,171,000 and 1,200,000 bbl. cement for Tygart Reservoir Dam, Pittsburgh, Pa., $2,040,000. In New York City, the Board of Transportation awarded the block signal and interlocking equipment and power equipment for the Independent Subway System, $4,505,000.

New capital is high due to sale of New York State bonds totaling $35,025,000 for new construction purposes. These were awarded at a new low interest rate for New York state of 2.302 per cent. Total new capital for the week is $36,988,000 in municipal bond sales less a $411,000 decrease in federal PWA allotments outstanding.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Mar. 1934	Weekly Average Prev.4 Weeks	Week Mar.14 1935
Federal Government	$9,000	$2,523	$5,933
State and municipal	13,413	10,134	16,825
Total public	$22,413	$12,657	$22,758
Total private	7,028	5,756	4,963
Week's total.....	$29,441	$18,413	$27,721

Cumulative to date:
1934...$340,089,000 1935...$266,873,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

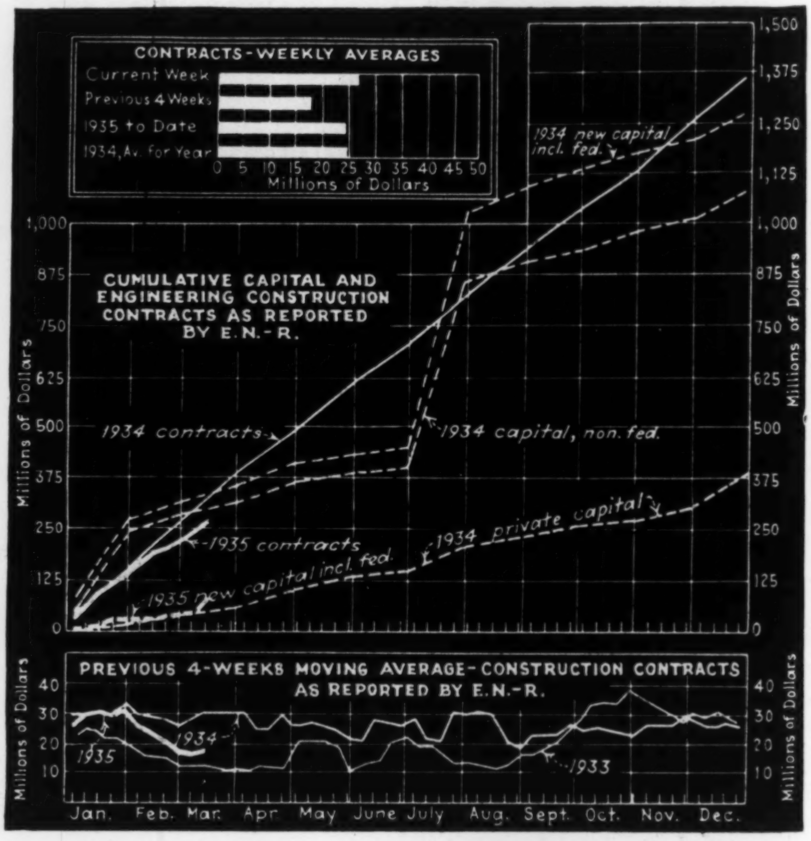
1935	Week Mar.14	Cumulative
State and municipal....	$36,988	$99,684
PWA allotment, S&M..	—430	—33,710
RFC loans, S&M.... ..	....	84
Corporate issues	....	....
PWA allotments, private	....	....
Total, Non-Federal..	$36,588	$73,367
PWA allotments, Federal Constr.	19	7,958
Total new capital......	$36,607	$81,325

Cumulative to date:
1934....$347,948,000 1935...$81,325,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

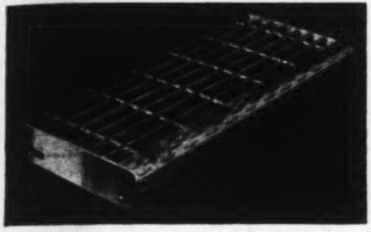
E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
Mar., 1935..	**193.46**	**93.00**	**Feb., 1935..**	**76**	**33**
Feb.,.. 1935..	196.02	95.52	Jan., 1935..	130	57
Mar., 1934..	194.06	93.20	Feb., 1934..	116	51
1934 (Av.)...	198.10	95.23	1934 (Av.)..	114	50
1933 (Av.)...	170.18	81.80	1933 (Av.)..	102	47
1932 (Av.)...	156.97	75.45	1932 (Av.)..	127	56



Construction Equipment and Materials

New Steel Stair Tread of Grating and Checkered Plate

A new stair tread designed especially for strength against impact and called the Electroforged stair tread, has been announced by the Blaw-Knox Co., Pittsburgh, Pa. The tread is constructed of steel grating and provided with a nosing made from rolled diamond checkered plate. The intersections of the bars of the grating are electrically forged into one piece under great pressure. This is done without cutting, slotting or punching the bars or removing any of the metal. The cross-bars of the grating are twisted to afford a grip for shoe soles.



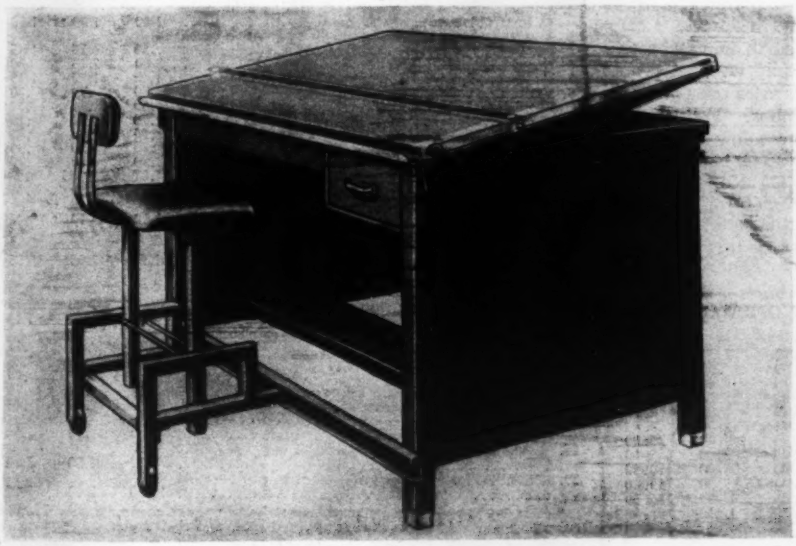
Electroforged stair tread has nosing of diamond checkered plate

Coaster Drafting Chair Provides Free Lateral Movement

A coaster drafting chair which provides free lateral movement in front of a drafting table and permits a forward and backward movement through a pivot in the lower part of the frame has been produced by the Hamilton Manufacturing Co., Two Rivers, Wis. The seat may be adjusted for height and proper distance from the table.

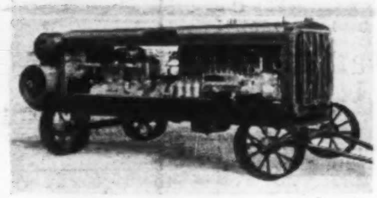
The front legs of the chair are supported on a lateral track attached to the drafting table, with ball-bearing fiber wheels running in a channel guide. The outside legs have ball-bearing casters. The chair is of steel construction and seat and back rail are padded with a brown leather-like material.

Hamilton Manufacturing Co.'s new drafting chair and table



Portable Air Compressor Driven by Diesel Engine

A new two-stage air compressor of the vertical water-cooled type, powered by a Caterpillar diesel engine, has been announced by Schramm, Inc., West Chester, Pa. The manufacturer states that the two-stage design greatly simplifies the flow of air. The new compressor is available in five sizes and can be secured with any type portable compressor mounting.



Schramm's new diesel-driven portable air compressor

Business Notes

CENTRAL IRON & STEEL CO., Harrisburg, Pa., announces the appointment of Irving M. Smith as assistant general sales manager.

KEYSTONE PORTLAND CEMENT CO., New York, N. Y., announces the appointment of Edwin K. Borchard as technical manager, with offices in Philadelphia, New York and Boston.

JOHNS-MANVILLE, New York, N. Y., announces that it has taken over Steeltex and a line of electrically welded steel fabric for concrete reinforcement. Steeltex is a fibrous backed mesh for use as a steel base for plaster walls and stucco exteriors and in reinforcement of concrete floor slabs.

New Equipment in Brief

Floor Plate. Multigrip, a new floor plate, has recently been announced by the Illinois Steel Co., Chicago, Ill. The maker states that in addition to having a high degree of skid resistance from every angle, the plate is featured by comfort underfoot. All lugs have a flat top surface. The plate may be cleaned readily and drains freely.

Meter Panel. A cabinet-type steel meter panel equipped with doors to protect and conceal meter and control connections is announced by the Bailey Meter Co., Cleveland, Ohio. The doors are provided with a three point locking mechanism. Self-supporting construction is secured by bending the sides of the panel back to form supporting wings.

Paver. The Ransome Concrete Machinery Co., Dunellen, N. J., announces a new paver, Model S-27-E. The new model, in comparison with the company's former models of paver, is characterized by greater horsepower, a longer boom, auxiliary water tank, larger pipes from tanks to drum, a simplified countershaft construction, larger clutches and trouble-proof crawler construction.

Rubber Insulation. Simplex Wire & Cable Co., Boston, Mass., announces Anhydrex, a recently developed, non-water absorptive, rubber insulation for wires and cables that are subjected in service to partial or complete submersion. The manufacturer states that rubber absorbs water and ordinary rubber insulation is not waterproof. The new product is the culmination of a research program to determine how absorption can be prevented.

Heavy Duty Trailer. A new heavy duty trailer has been announced by the C. R. Jahn Co., Chicago, Ill. The new model is of the conventional "goose neck" type, but the main bearing construction is new. The beam runs from rear to front of the trailer and the goose neck is secured by cutting one flange, bending and taking a triangular piece out of the web and welding it back together again. Either pneumatic or solid tires can be had.

New Publications

ADAMS ROAD MACHINERY, J. T. Adams Co., Indianapolis, Ind., 5x8, 24 pages.

AFTERCOOLERS FOR AIR OR GAS, Ingersoll-Rand, New York, N. Y. 8½x11, 12 pages.

JOHNSON WELL SCREENS, Edward E. Johnson, Inc., St. Paul, Minn., 8½x11, 24 pages.

INDOOR FORCED DRAFT SPRAY COOLING TOWERS, Binks Manufacturing Co., Chicago, Ill., 8 pages.

SPARLING MAIN-LINE WATER METERS, R. W. Sparling, Los Angeles, Calif., 8½x11. 16 pages.

SPECIAL ATTACHMENTS FOR SPECIAL NEEDS, Caterpillar Tractor Co., Peoria, Ill., 8½x11. 48 pages.

TABLES OF CONVERSION FACTORS FOR ENGINEERS, 16 pages, 4x5, The Dorr Company, Inc., New York, N. Y.

MINING, QUARRY AND GRAVEL PIT MACHINERY, Smith Engineering Works, Milwaukee, Wisc., 7½x10½. 31 pages.

TWO-STAGE AIR-COOLED PORTABLE COMPRESSORS, Chicago Pneumatic Tool Company, New York, N. Y. 8½x11, 20 pages.

TWO-STAGE, AIR-COOLED PORTABLE COMPRESSORS AND TOOLS, Ingersoll-Rand Co., Phillipsburg, N. J., 8½x11, 56 pages.

GOODRICH ENGINEERING DATA, INDUSTRIAL RUBBER GOODS, B. F. Goodrich Co., Mechanical Division, Akron, Ohio, 8½x11. 21 pages.

SERVICE RECORDS OF EXISTING CAST IRON MAINS, Cast Iron Pipe Research Association, Chicago, Ill. 8½x11, 32 pages.

USE OF COPPER SULPHATE IN CONTROL OF MICROORGANISMS, Nichols Copper Co., New York, N. Y. 6x9, 36 pages. A discussion by Frank E. Hale, director of laboratories, New York City water department.

Current Construction Unit Prices

Concrete Sewer Pipelines, New Orleans

LATE in January, 1935, contract was awarded by the city of New Orleans for the construction of 5,000 ft. of concrete pipe sewers, ranging in size from 6 to 36 in. The work is a PWA project, to be completed within six months, and consists of laying and connecting of the pipe with the Melpomene canal, from the river side of St. Charles Ave. from Lee Circle to Felicity St. The following summary lists the three low bidders and unit prices: (A) Forcum-James Co., Dyersburg, Tenn. (contract) $34,545; (B) Michael J. Flynn, New Orleans, $36,848; (C) Hart Enterprise Electric Co., New Orleans, $54,582.

CONCRETE PIPE LINES, NEW ORLEANS, LA.

Item	Quantity	Unit Prices A	B	C
1.	Excav., backfilling, grading—3760 cu.yd	$1.80	$2.00	$5.45
2.	Brickwork—5 cu.yd	25.50	23.00	61.60
3.	Subgrade decking—1,000 F.B.M.	100.00	40.00	77.00
4.	36-in. Drain pipe in place—295 lin.ft	6.40	6.50	8.10
5.	30-in. Drain pipe in place—595 lin.ft	4.85	5.30	6.16
6.	27-in. Drain pipe in place—610 lin.ft	4.10	4.86	4.93
7.	24-in. Drain pipe in place—675 lin.ft	3.10	3.47	3.40
8.	21-in. Drain pipe in place—500 lin. ft.	2.25	2.40	2.36
9.	18-in. Drain pipe in place—470 lin.ft	1.75	1.90	1.80
10.	15-in. Drain pipe in place—1,110 lin.ft	1.35	1.48	1.37
11.	10-in. Drain pipe in place—630 lin.ft	.90	.85	.66
12.	6-in. Drain pipe in place—50 lin.ft	.75	.85	.33
13.	Manhole No. 1 complete in place (18 each 5 ft.)—90 vert.ft	15.00	21.35	27.50
14.	Manhole No. 2 (4 each 5 ft.)—20 vert.ft	17.00	22.70	30.21
15.	Manhole No. 3 (1 each 9 ft.)—9 vert.ft	20.00	24.00	31.90
16.	Catch basin No. 1 comp. in place—2 each	55.00	62.15	49.54
17.	Catch basin No. 2—16 each	58.00	67.00	61.60
18.	Catch basin No. 3—2 each	60.00	72.20	73.92
19.	Take up and relay artificial stone walk—170 sq.yd.	2.20	2.50	3.85
20.	Take up and relay brick sidewalk—60 sq.yd.	1.00	1.10	1.54
21.	Take up and relay asphalt paving—2,000 sq.yd.	4.75	4.50	6.00
22.	Steel protected concrete curbing—100 lin.ft	1.50	2.75	1.85
23.	Take up and reset stone curbing—210 lin.ft	1.00	.60	.70
24.	Cleanouts, complete in place—4 each	10.00	5.00	5.40
25.	Take up and relay gravel pavement—100 sq.yd.	1.00	2.00	1.08
26.	Take up and relay concrete gutter bottom—60 sq.yd.	2.00	2.70	3.85
27.	Take up and relay brick gutter bottom—10 sq.yd.	3.00	5.00	6.16
28.	Take up and relay tile pavement—5 sq.yd.	4.00	5.00	7.70
29.	Hand filling in place—100 cu.yd	5.00	2.00	2.31

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Ft. Peck Dam Sheetpile Cutoff Wall

CONTRACT was awarded in July 1934 for the construction of the steel sheetpile cutoff wall required for the Ft. Peck dam. The work consists of a single line of interlocking steel piles extending across the entire Missouri River valley except at the river channel, driven to the underlying rock formation to form the watertight cutoff wall for the earth dam, and varying from 40 ft. to 150 ft. in depth. The contract also includes the core trench for the earth dam and the necessary grouting along and beneath the pile wall. Completion is scheduled for 300 days with PWA rates prevailing, of $1.20 for skilled and 55c. for common labor. Following are the total and unit bid prices for the three low bidders: (A) Frazier-Davis Construction Company and G. L. Tarlton, St. Louis, Mo. (contract) $2,157,840.00; (B) Kansas City Bridge Co., Kansas City, Mo., $2,285,280.00; (C) Massman Construction Co., Kansas City, Mo., $3,995,104.50. Contract was let by the Corps of Engineers. Maj. Thos. B. Larkin is District Engineer in charge.

FT. PECK DAM STEEL SHEET PILE CUT OFF WALL

Item		A	B	C
1.	Rock excavation—6,100 cu.yd	3.00	2.50	4.25
2.	Common excavation (dry)—88,100 cu.yd	.60	.50	1.10
3.	Common excavation (wet)—16,500 cu.yd	0.70	1.00	6.95
4.	Concrete—3,400 cu.yd	12.00	15.00	35.20
5.	Reinforcing steel—1,000 lb	0.10	.06	0.15
6.	Steel sheet piles in place—1,042,100 S.F	1.90	2.00	3.42
7.	Supports for cut-off wall, complete—460	50.00	100.00	75.00
8.	Drill grout holes—560 l.F	4.00	2.00	3.60
9.	Grout with neat cement—200 cu.yd	30.00	30.00	50.00
10.	Grout, 1 part cement, 1 part sand—500 cu.yd.	32.00	35.00	50.00
11.	Remove and replace Trestle A—Lump Sum	2,000	1,200	755.50
12.	Remove and replace Trestle B—Lump Sum	3,000	1,200	755.50
13.	Remove and replace Trestle C—Lump Sum	2,000	1,200	755.50

Ft. Peck Dam Spillway

CONTRACTS were awarded on Oct. 26, 1934, to Martin Wunderlich, Jefferson City, Mo., for Priority 2, and on November 19, 1934, to Massman Construction Company, Kansas City, Mo., for Priorities 1, 3 and 4 to include all work in the construction of the new Ft. Peck Dam spillway located on the Missouri River 25 miles southeast of Glasgow, Montana. Bids were originally taken on the four priorities on Sept. 24, 1934, but with the exception of Priority 2, were readvertised and opened Nov. 12, 1934. The contract amounts based on present awards exceed the original combined low bid by $383,000. Detailed description of the work is given in *ENR* Nov. 29, 1934. PWA rates establish $1.20 per hour for skilled labor and $.50c for unskilled. The Government furnishes all cement, sand, gravel and waterproofing materials required f.o.b. contractor's siding. Unusual features of construction are the three methods of treating the surfaces of the shale left exposed by excavation providing for (1) Three coat spray of liquid sealing solution to be applied not later than 2 hours after excavation with not greater than 10 hour intervals between the applications, (2) waterproofing solution to be applied to previously treated or untreated surfaces as directed in one or more coats, (3) gunite ½ in. minimum coating to be applied on surfaces not otherwise treated. Capt. Theo. Wyman, Jr., is district engineer at Ft. Peck.

FT. PECK DAM SPILLWAY—PRIORITY 2

	Total Bid
A—Martin Wunderlich (contract) Jefferson City, Missouri	$1,168,120.00
B—Addison Miller, Inc. and Fielding & Shepley, Inc	1,340,650.00

Item	Quantity	Unit Prices A	B
1.	Shale excav. 1,327,000 cu. yd	0.45	0.55
2.	Overburden excav. 1,481,000 cu. yd.	0.37	0.40
3.	Furnish, place, sheeting and bracing—50M f.b.m.	100.00	200.00
4.	Apply complete liquid sealing (3 coats)—6,000 sq.	2.00	1.00
5.	Apply bituminous spray waterproofing—6,000 sq. (each coat)	1.00	0.40

FORT PECK DAM SPILLWAY—PRIORITIES 1, 3 AND 4

	Total Bid
A—The Massman Construction Company, Kansas City, Mo. (contract)	$7,133,005.00
B—Marsch, Hardwick & Company, Chicago, Ill	7,193,420.00
C—Six Companies of Washington, Inc., San Francisco, Calif.	7,435,212.00

Item		Unit Prices A	B	C
1.	Shale excavation—5,250,000 cu. yd.	.3975	.43	.53
2.	Overburden excavation*—5,300,000 cu. yd.	.3975	.43	.31
3.	Furnish, place sheeting and bracing—100M f.b.m.	70.00	75.00	70.00
4.	Apply complete 3 coats liquid sealing solution—44,100 sq.	1.00	1.00	1.70
5.	Apply bituminous spray water-proof solution (each coat)—62,500 sq	.50	.75	1.45
6.	Furnish and place 18 in. pipe drains—6,500 l.f.	3.00	2.15	2.30
7.	Furnish and place 12 in. pipe drains—3,000 l.f.	1.50	1.20	1.15
8.	Furnish and place 8 in. pipe drains—52,000 l.f.	.70	.70	.70
9.	Furnish and place 6 in. pipe drains—69,000 l.f.	.60	.55	.52
10.	Furnish and place steel vent pipes—23,000 lb.	.20	.20	.14
11.	Backfill—50,000 cu. yd	.50	1.00	.63
12.	Place gravel fill in tile drain ditch—32,000 cu. yd	.70	.80	.75
13.	Place gravel fill in surface drain ditch—12,000 cu. yd.	.70	.80	.70
14.	Furnish and place steel sealing strips—1,445,000 lb.	.07	.045	.051
15.	Furnish and pour asphaltic const. joint—115,000 l.f.	.20	.10	.115
16.	Mix and place concrete, channel bottom—175,900 cu. yd	3.50	2.50	3.45
17.	Mix and place concrete, channel walls—66,200 cu. yd.	3.50	4.50	5.00
18.	Mix and place concrete, drainage ditches—7,000 cu. yd	3.50	7.00	5.20
19.	Furnish, place precast conc. blocks, surface drains—35,000 sq. yd	2.00	2.00	2.30
20.	Gunite coating—5,000 sq.	5.00	7.00	5.75
21.	Drill grout holes—5,000 l.f.	1.00	.50	1.15
22.	Furnish and install grout pipes and connections—5,000 lb.	.20	.15	.17
23.	Grouting—2,000 cu. ft.	1.00	1.00	1.15
24.	Furnish, place reinforcing steel—36,000,000 lb.	.0425	.0375	.04
25.	Furnish, place wire mesh reinforcing—10,000 lb.	.10	.10	.10
26.	Bitumen A applied in gravel base course—15,000 gal.	.20	.16	.22
27.	Placing, preparing gravel base for pavement—35,000 sq. yd	.50	.50	.50
28.	Bituminous 2 in. conc. base course in place—3,410 tons	8.00	6.00	7.40
29.	Bituminous 1 in. top course, conc. in place—1,705 tons	10.00	7.00	7.60

* Item 2—The Government reserves right to remove approximately 750,000 cu. yd. of overburden excavation by hired labor and rented plant.